Accuracy of Findings of Ultrasound (USG) Examination in Pediatric Patients with suspected Appendicitis with Intraoperative Findings

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Abstract : Background & Objectives: Unspecified lower abdominal pain might confuse clinicians in diagnosing pediatric appendicitis. Ultrasonography, as an initial affordable tool, has been learned its role in reducing unnecessary appendectomy. This study aimed to determine the accuracy of ultrasonography in pediatric acute appendicitis and its correlation to intraoperative findings, confirmed by histopathology results. The result would verify other study experience.

Methods : The study was a diagnostic study which retrospectively review the children who underwent an ultrasound study for suspected appendicitis in pediatric surgery division of Haji Adam Malik Hospital and Universitas Sumatera Utara Hospital, Medan, North Sumatera between January 2014 until March 2019. We determined the accuracy along with sensitivity and specificity results of Ultrasonography (USG) using calculated formula. The comparison between ultrasonography results and intraoperative findings was analyzed using Chi Square test or its alternative.

Results : Among the 32 patients, male and female were almost equal in 1:1 ratio, with mean age of 14.06 (±3.98) years old. Twenty-six patients were positively diagnosed as appendicitis using ultrasonography. Only two patients have no appendicitis based on intraoperative findings, confirmed by histopathology results. There is a statistically significant difference between ultrasonography findings and histopathology results (p=0.03). We obtained the accuracy of ultrasonography in predicting appendicitis was 87.5%, with 86.7% sensitivity and 100% specificity.

Conclusion : Our results compare favorably with alternative studies, however indicate the potential for improvement in accuracy of image, with a future study incorporating new ways of categorizing ultrasound findings presently being undertaken.
Introduction

The diagnosis of acute lower abdominal pain in children is a challenge for the surgeon. Acute appendicitis is the most common cause of acute abdomen. Diseases similar to acute appendicitis are acute gastrointestinal and gynecological diseases. This paper reviews the ultrasound findings of acute appendicitis in children with a focus on imaging instructions for specific diagnoses. This has an impact on diagnostic accuracy and intraoperative management.

In the pediatric population, appendicitis is the most frequent in the second decade and rarely occurs in children under the age of 2 years (Sivit CJ; 2004). The classic clinical presentation is the onset of acute abdominal pain originating from the periumbilical region and migrating to the right lower quadrant. Abdominal distention and tenderness in the abdomen can be found if there is obstruction or intestinal perforation. About one third of children with appendicitis have atypical clinical signs and symptoms (Kaneko K; 2004). In adolescent women, in particular, gynecological disorders can cause acute lower abdominal pain that resembles appendicitis.

Ultrasonography is the imaging modality most often used in the evaluation of children suspected of appendicitis. The importance of ultrasonography in the management of appendicitis in children is able to help distinguish appendicitis from other abdominal and pelvic abnormalities that resemble appendicitis (Sivit CJ; 2001). About a quarter to one-third of children referred for sonographic evaluation of suspected appendicitis will have the condition and a quarter to a third of children will have another diagnosis, usually gastrointestinal and gynecological diseases, which are found on ultrasonography (Siegel MJ; 1991). Many children These children, nearly one third to half, will experience abdominal pain disappearing before a specific diagnosis is made (Sivit CJ; 2001). Other intra-abdominal diseases with acute appendicitis are gastroinestinal diseases and acute gynecological abnormalities (Siegel; 1991). Thus, the entire abdomen and pelvis should be examined in children who have a normal graded compression check from the right lower quadrant and there is no evidence of appendicitis by ultrasonography.

Other supportive examination of the abdomen, which is simple, but rarely can diagnose appendicitis. Its main role is to assess the potential complications associated with acute inflammation, namely intestinal obstruction and perforation.

Computed Tomography (CT) scans play a role in obese patients and they complain of abdominal pain that cannot tolerate compression-graded sonographic techniques. CT scan is also useful in patients with suspected perforated appendicitis and periappendiceal abscess, because it helps to make a diagnosis and determine whether percutaneous abscess drainage can be done safely. There is agreement that imaging techniques improve both of these clinical scenarios, because of the potential for early diagnosis and high sensitivity (CT, MRI) and specificity (USG, CT, MRI) (Humes DJ; 2006).

A recent study showed that increasing pre-operative imaging use in patients with acute appendicitis saves costs and reduces Negative Appendectomy Rate (NAR) (Boonstra; 2014).

Poortman et al. Conducted a research at the Department of Surgery, St. Elisabeth Hospital Tilburg, Tilburg, Netherlands in 2009 recommending a diagnostic model of graded compression USG appendicitis as the initial imaging modality followed by CT scan examination. This model was applied to a relatively small group of patients in this study, it was found that ultrasound examination dramatically increased sensitivity (100%), specificity (85%), and accuracy (92%), and gave an 8% Negative Appendectomy Rate and no appendicitis missed. These results are similar to those in the study of Poortman et al. (sensitivity of 100%, specificity of 86%, and Negative Appendectomy Rate of 8%), Ramarajan et al. (99% sensitivity, 91% specificity, and 7% Negative Appendectomy Rate), and Thirumoorthi et al. (sensitivity 94.2%, specificity of 97.5%, Appendectomy negative appendicitis Rate 1.8%, and Appendicitis missed 0%).

Currently at other institutions Ultrasonography (USG) studies of appendicitis have been carried out in children with intraoperative findings and confirmed by histopathological examination results, so the researcher intends to examine whether there is a relationship between ultrasonography (USG) in pediatric appendicitis and intraoperative findings and confirmed by histopathological examination at H. Adam Malik General Hospital and North Sumatra University Hospital Medan to prove whether the accuracy of the diagnosis of acute appendicitis in children with Ultrasound (USG) examination at RSUP H. Adam Malik and University of North
Sumatra Hospital Medan is as accurate as other institutions, so that it can be verified. An ultrasound at H. Adam Malik Hospital and University of North Sumatra Hospital Medan is similar to an ultrasound examination in another hospital in diagnosing pediatric appendicitis.

**Methods**

The study was a diagnostic study which retrospectively review the children who underwent an ultrasound study for suspected appendicitis in pediatric surgery division of Haji Adam Malik Hospital and Universitas Sumatera Utara Hospital, Medan, North Sumatera between January 2014 until March 2019. We determined the accuracy along with sensitivity and specificity results of Ultrasonography (USG) using calculated formula. The comparison between ultrasonography results and intraoperative findings was analyzed using Chi Square test or its alternative.

All patients with appendicitis <18 years old, who had done ultrasonography (USG) and appendectomy surgery were included.

**Results**

A total of 32 subjects were included in this study. The characteristics of the subjects in this study are shown in Table 1, based on sex, girls had more appendicitis as many as 17 people (53.1%) compared to 15 boys who suffered appendicitis (46.9%). Based on the age of children who suffer from appendicitis on average 14 years old. Based on the results of the ultrasound obtained as many as 26 people (81.3%) children suffering from appendicitis while the results of histopathological examination as many as 30 people (93.8%) children suffer from appendicitis.

**Table 1 Characteristics of Research Subjects**

| Characteristics                        | n=32 |
|----------------------------------------|------|
| Gender, n (%)                          |      |
| Male                                   | 15 (46.9%) |
| Female                                 | 17 (53.1%) |
| Age (Year), Mean±S.D                   | 14.06±3.983 |
| Ultrasound Results (USG), n(%)         |      |
| Appendicitis                           | 26 (81.3%) |
| Not Appendicitis                       | 6 (18.8%) |
| Overview of histopathology             |      |
| Appendicitis                           | 30 (93.8%) |
| Not Appendicitis                       | 2 (6.3%) |

The used analysis test was an alternative test from chi square, namely Fisher Exact test because the data distribution did not meet the chi square test requirements. Based on the analysis test used, it was found that there was a relationship between USG results and significant intraoperative findings from histopathological features with a value of p <0.05 (p = 0.030)
Table 2 Accuracy of USG Results and Intraoperative Findings of Childhood Appendicitis

| Histopathology Findings n(%) | Total | P* |
|------------------------------|-------|----|
| Appendicitis | Not Appendicitis | | |
| Ultrasonografi (%) | 26 (86.7%) | 0 (0.00%) | 26 (81.3) | 0.030 |
| Sensitivity (%) | 86.7 | 99 |
| Specificity (%) | 87.5 | 99 |
| Accuracy (%) | 33.3 |
| PPV (%) | 99 |
| NPV (%) | 33.3 |

From the results of ultrasonography (USG), 86.7% sensitivity and specificity > 99% were obtained. Accuracy of ultrasonography in diagnosing appendicitis was found to be 87.5%. False positive results from ultrasound were not found in this study. False negatives were found in two cases (6.65%). Positive predictive value reaches > 99% and negative predictive value is 33.3%

Discussion

High specificity (99%) of all studies shows that ultrasound is a useful test to rule out the presence of appendicitis, even with relatively low diagnostic results, identifying appendices 40.7% of the time. Similarly, the LR (LR = 0.13) calculated from this study is sufficient to potentially influence the path of doctor’s decision making. This is reflected in the negative appendectomy rate of 13.3%, with 4 negative appendectomy performed. False negative results due to ultrasound findings in the appendix appear lymphoid hyperplasia, causing dilatation of the appendix lumen and an increase in the appendix diameter, so that it is considered positive because of enlarged diameter.

Because this study is retrospective, a binary diagnosis model is used, where doubtful findings (appendices) are integrated into positive or negative findings. These results reflect the potential limitations of ultrasound to confirm or rule out the diagnosis of appendicitis, because the appendix is not always sonographically identified. The difference in visualization ability of each operator that was not assessed in this study is thought to have a role in identifying univocal findings or unusual images.

Sensitivity (86.7%) and specificity (> 99%) in the study showed a significant association between USG findings and histopathological results resembling those of other centers but these results were considered not yet capable of including findings that were still vague. This shows the need for developing a systematic approach in visualizing the appendix.

One limitation of this study is the missing data, especially for visualization evidence from the appendix through ultrasound and a complete description of the appendix, such as diameter and compressibility. To limit selection bias, all eligible studies were included, and there was no control over the experience of staff conducting ultrasound examinations.

Conclusion

Compared to alternative studies, our study shows similarities in results. Ultrasound can be useful as an initial diagnostic tool that is quite accurate and specific in diagnosing appendicitis in children. It is necessary to improve the accuracy of images in further studies and systematic approaches to visualize appendicitis findings in children.
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