

## The Role of Secondary Sonographic Signs in Diagnosis of Acute Appendicitis in Pediatric Patients

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### ABSTRACT:

#### BACKGROUND:

Appendicitis is the commonest surgical emergency in pediatric patients. Although the diagnosis is mainly clinical, imaging studies can be used to enhance diagnosis. Ultrasound is widely used as a screening tool because it is readily accessible in most centers, cost effective, and radiation free, but still there is a percentage of (equivocal study), so searching for secondary inflammatory sonographic signs may enhance the diagnosis.

#### AIM OF STUDY:

To assess the role of secondary sonographic signs in diagnosis of acute appendicitis in pediatric patients.

#### PATIENTS & METHOD:

This is a prospective study involved 187 patients (121 males, 66 females) done in Baghdad Medical city/ Children Welfare Teaching Hospital /Pediatric Surgery department between November 2018 and November 2019, all presented with abdominal pain mainly at right iliac fossa, patients sent for abdominal ultrasound, complete blood count, urinalysis, and histopathological examination of surgical specimens.

#### RESULTS:

Secondary signs have sensitivity of 53.7%, specificity of 80.0%, PPV of 97.9%, NPV of 8.9%, and accuracy of 55.1%.

There is significant statistical difference in rate of detecting SS (p-value=0.038).

#### CONCLUSION:

Secondary signs have high specificity but fair or low sensitivity. Multiple secondary signs in one patient make the ultrasound more valuable in diagnosis.

**KEYWORDS:** Appendicitis, Ultrasound, Secondary sonographic signs.

### INTRODUCTION:

Acute appendicitis is the most common emergency presentation that requires surgical intervention in both adults and children. Since the 1980s, ultrasound has been commonly used in diagnosis of appendicitis with a range of sensitivities (71.2–99%) and specificities (91.3–98.2%).<sup>[1,2,3,4,5,6]</sup>

There is currently some debate about the best imaging modality or combination of modalities to accurately and cost-effectively diagnose appendicitis. Studies have variously advocated ultrasonography in all presentations as a first-line modality.<sup>[7,8]</sup>

Definitive sonographic criteria or techniques that increase accuracy and assist diagnosis would be of particular benefit. Secondary signs of appendicitis are well established with a recent

investigation of their predictive value identifying potential diagnostic use in the absence of an identifiable appendix.<sup>[2,9,10]</sup> Graded compression of the right lower quadrant remains the cornerstone of sonographic technique for evaluating appendicitis, adequate pressure is reached if the psoas muscle and iliac vessels are visualized.<sup>[11]</sup>

The appendix is a blind-ended tubular structure with identifiable concentric, alternating hyper and hypoechoic layers of the wall (bowel wall signature). The lumen is usually filled with air. The appendix has an upper normal diameter of 6 mm in short axis. An average appendiceal diameter of 4.2 mm (+/- 0.9 mm) has been found in normal pediatric appendices.<sup>[12]</sup>

A normal appendix should be compressible, usually to near obliteration. There is little or no blood flow in the wall. The inflamed appendix is enlarged with a diameter of more than 6 mm. It is often non-compressible and fluid-filled.<sup>[13]</sup>

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## SONOGRAPHIC SIGNS IN DIAGNOSIS OF ACUTE APPENDICITIS

A diameter more than 6 mm and non-compressibility are the most sensitive and specific in diagnosis of appendicitis.<sup>[14]</sup>

The inflamed appendix can show hyperemia to the wall. Blood flow on color imaging is rarely identifiable in a normal appendix.<sup>[14]</sup>

Caution is required; however, as lack of hyperemia in the wall may be associated with perforated appendix.<sup>[15]</sup>

An inflamed appendix surrounded by phlegmon or abscess also indicates appendiceal perforation.<sup>[11]</sup>

Identification of the abnormal appendix is the most precise finding to diagnose appendicitis. However, there is a high percentage of reports where the appendix is not visualized; so, secondary signs are helpful in identifying an inflammatory condition, these signs include: enlarged mesenteric lymph nodes, increased echogenicity of mesenteric fat, local fluid collection, thickened cecal wall, inflamed omentum (by sonographic criteria), and ileus of regional bowel<sup>[14][16]</sup>.

### AIM OF STUDY:

To assess the role of secondary sonographic signs in diagnosis of appendicitis.

### PATIENTS & METHODS:

#### 2.1. Study design:

A prospective study carried out in Baghdad Medical City/Children Welfare Teaching Hospital /Pediatric Surgery Department over a period from November 2018 to November 2019.

#### 2.2. Sample Size:

A Total 187 patients (121 males, 66 females) involved in the study, younger age was 3.5 years, older age was 14 years, with mean age of 10.1 years, appendectomy done for all 187 patients.

#### 2.3. Exclusion Criteria:

1- Mild clinical course with resolution of symptoms after a brief period of observation.

2- Other diagnosis than acute appendicitis.

#### 2.4. Data Collection Tool

A questionnaire had been applied to all patients to collect needed information; it was filled by the researcher through direct interview with the mothers or care givers of study patients and also colleagues in charge of following up each patient.

The collected data included: patient name, age, presenting symptom, duration of symptom, abdominal ultrasound findings about appendix itself and secondary sonographic signs, patient operated or treated conservatively, operative findings.

#### 2.5. Ultrasound examination

After thorough history and physical examination, patients sent for laboratory investigations and abdominal ultrasound examination.

#### RESULTS:

In this study, 187 patients involved, minimum age was 3.5 years, maximum age was 14 years, their age and gender distribution shown in [table 1].

Table 1: Age and gender distribution of study sample.

		No	%
Age (years)	3.5---5y	5	2.7
	5---10y	56	29.9
	10---14y	126	67.4
	Mean±SD (Range)	10.1±2.4 (2-14)	
Gender	Male	121	64.7
	Female	66	35.3

Abdominal U/S findings were as following:

Appendiceal findings:

In 112 patients (59.9 %) vermiform appendix could not be visualized.

In 75 patients (40.1 %) vermiform appendix was visualized with diameter ranging from 5 mm to more than 11 mm.

Secondary sonographic signs found in 97 patients, details shown in [Table 2].

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**Table 2: Secondary sonographic signs on abdominal U/S .**

		No	%
US Secondary findings	Present	97	51.9
	Not	90	48.1
	One	60	32.1
	Two	27	14.4
	Three	8	4.3
	Four	2	1.1
Free Fluid	Yes	43	23.0
	No	144	77.0
Mesenteric LAP	Yes	41	21.9
	No	146	78.1
Localized Ileus	Yes	25	13.4
	No	162	86.6
Increased mesenteric fat echogenicity	Yes	24	12.8
	No	163	87.2
Inflamed omentum	Yes	11	5.9
	No	176	94.1
Thickened Cecal wall	Yes	2	1.1
	No	185	98.9

Among 187 patients who were operated on, 1 case had right ovarian cyst, 4 cases had Inflamed appendices found in 177 Meckel's diverticulum, one of them was patients(94.7%), 10 patients(5.3%) had normal perforated, as shown in[table 3] . appendix, 5 of them had other operative findings:

**Table 3: Operative appendiceal findings.**

Appendicular operative findings	No.	Percentage
Severely inflamed AP	76	40.6%
Inflamed AP	76	40.6%
Perforated	12	6.4%
Hyperemic	7	3.7%
Impending rupture	3	1.6%
Gangrenous AP	2	1.1%
Appendicular mass	1	0.5%
Normal	10	5.3%

**Table 4: Categorize patients according to number of secondary signs visualized with their PPV.**

Number of secondary signs	Total	AA.	PPV
1 secondary sign	60	59	98 %
2 secondary signs	27	26	96 %
3 secondary signs	8	8	100 %
4 secondary signs	2	2	100 %

Table 4.patients' categories according to no. of SS with PPV

Surgical findings of acute appendicitis according to secondary signs shown in [Table 5].

## SONOGRAPHIC SIGNS IN DIAGNOSIS OF ACUTE APPENDICITIS

**Table 5: Surgical findings of acute appendicitis according to secondary signs**

Secondary Signs	Total	AA.
1-Free Fluid	43	42
2-Mesentric LAP	41	40
3-Localized Ileus	25	24
4-Increased mesenteric fat echogenicity	24	24
5-Inflamed omentum	11	11
6-Thickened Cecal wall	2	2

Statistical analysis of secondary signs shown in [Table 6]

**Table 6: Statistical analysis of secondary signs in acute appendicitis.**

	Sensitivity	Specificity	PPV	NPV	Accuracy rate
US Secondary findings	53.7%	80.0%	97.9%	8.9%	55.1%
1-Free Fluid	23.7%	90.0%	97.7%	6.3%	27.3%
2-Mesentric LAP	22.6%	90.0%	97.6%	6.2%	26.2%
3-Localized Ileus	13.6%	90.0%	96.0%	5.6%	17.7%
4-Increased mesenteric fat echogenicity	13.6%	100%	100%	6.1%	18.2%
5-Inflamed omentum	6.2%	100%	100%	5.7%	11.2%
6-Thickened Cecal wall	1.1%	100%	100%	5.4%	6.4%

### DISCUSSION:

In this study, the sensitivity and specificity for the presence of any secondary sign in diagnosing appendicitis were 53.7% and 80% respectively, which is relatively comparable to study done by Ross et al<sup>[17]</sup> who found that the sensitivity and specificity for the presence of any secondary sign in diagnosing appendicitis were 40.2% and 90.6% respectively.

The PPV of SS in our study was as following: in patients had only one SS, the PPV was 98% which is more than what was found in Mirza et al<sup>[18]</sup> study(70%), in patients had two SS, the PPV was 96% which is also higher than Mirza et al study(78%). In patients had three or four SS, the PPV was 100% for both groups which is identical to Mirza et al study(100% for both), because the sample study of Mirza et al included also patients who were treated conservatively and their age limit was up to 16 years .

In our study, Mesenteric LAP found to have (SN 22.6% and SP 90%), which is comparable to Mirza<sup>[18]</sup> et al(SN 19%,SP 100%) and to Estey et al<sup>[19]</sup> (SP 81%) studies, but incomparable to Kessler et al<sup>[14]</sup> results (SN 32%, SP 62%)

Free fluid found to have (SN 23.7% , SP 90%), SN was comparable to study done by Ross<sup>[17]</sup> et al(SN 20.7%), but incomparable to study done by Mirza<sup>[18]</sup> et al (7%) and Kessler<sup>[14]</sup>(SN 51%), while SP value in our study was comparable to

Ross study ( 93.6%), Estey et al (SP 98%), and Mirza et al ( SP 100%), but incomparable to Kessler<sup>[14]</sup> et al results (SP 71%) who included adult patients in his study and may be this is the cause of difference .

Localized ileus had SN 13.6% and SP 90%, both were fairly comparable with Mirza et al study ( SN 9%,SP 100%).

Increased mesenteric fat echogenicity had (SN 13.6%,SP 100%), both values were very near to Mirza et al results (SN 12%,SP 99%), Ross et al(SN 10.9% SP 98.4%), and also to Estey et al (SP98%), but incomparable to Kessler et al results (SN 91%, SP 76%).

Thickened cecal wall had (SN 1.1%, SP 100%), comparable to Mirza et al results (SN 4%,SP 100%), but incomparable to Kessler et al<sup>[14]</sup> results (SN 25%, SP 88%).

Inflamed omentum had (SN 6.2% and SP 100%), Mirza et al found SN 1% and SP100%.

Kessler et al involved smaller patients sample (125 patients) and was not limited to children, this may be the cause of different results.

Echogenic mesenteric fat has a PPV for appendicitis of 100% in our study, which is very near to Lee et al<sup>[9]</sup> result (PPV 99%).

Appendix nonvisualization rate in our study was 59.9% (appendix not visualized in 112 out of 187 cases), which is within the range found in Wiersma et al study<sup>[2]</sup> and Nielsen et al<sup>[20]</sup> study(25-60%), and also near to Ross<sup>[17]</sup> et al

study(54%), but more than Estey<sup>[19]</sup> et al (37.7%) and Kessler<sup>[14]</sup> et al (16.8%).

There are some studies<sup>[21]</sup> suggesting increment in appendiceal luminal diameter with age, this may explain the better visualization rate in Estey<sup>[19]</sup> et al study and Kessler<sup>[14]</sup> et al study since their samples' age limits were more extended than ours (up to 18years and up to 83 years respectively).

Our study shows significant statistical difference in rate of detecting SS (p-value=0.038), Jenny M. et al<sup>[22]</sup> study also found statistically significant result (P-value=0.005).

#### CONCLUSION:

Secondary signs were significant (high specificity, high PPV, and significant *P*-value), searching for secondary signs is beneficial especially in cases with non-conclusive clinical picture in order not to miss some patients with acute appendicitis, presence of multiple secondary signs in one patient makes the ultrasound more valuable in diagnosing acute appendicitis.

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