

# Ripple Effect

Ultrasound reflections

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# The Challenge of Appendicitis



In this module, you shall find cases depicting various flavours of the perennial dilemma aka appendicitis.

## Learning Objectives:

1. To review sonographic technique and protocol in suspected appendicitis.
2. To introduce a categorical approach to the interpretation of appendix ultrasound in children.

## Technique of Appendix Ultrasound:

1. Ask the patient to point to area of pain.
2. Use a high frequency linear transducer.
3. Start scanning over bladder to get a quick impression of how distended it is, to look for obvious free fluid in pelvis and RLQ, and to scan retrovesical region. In females, look for adnexal mass.
4. While focusing in RLQ, use the graded compression technique.
5. Look for appendix draped over iliac vessels. Appendix must be seen in its entirety, from base of cecum to the tip.
6. Pay careful attention to its compressibility, peristalsis, wall thickness, luminal contents, and surrounding structural abnormalities.
7. Evaluate liver, GB, pancreas, kidneys & lung bases for pneumonia.

## Technique of Appendix Ultrasound:

In case of non visualization of appendix, look for supporting signs that could potentially point to inflammatory pathology –

1. Mesenteric edema / Periappendiceal fat stranding
2. Perifocal free /loculated fluid collection
3. Bowel wall thickening
4. Lack of normal peristalsis of adjacent small bowel
5. Appendicolith

Significant tenderness on graded compression is a useful indicator of underlying pathology.

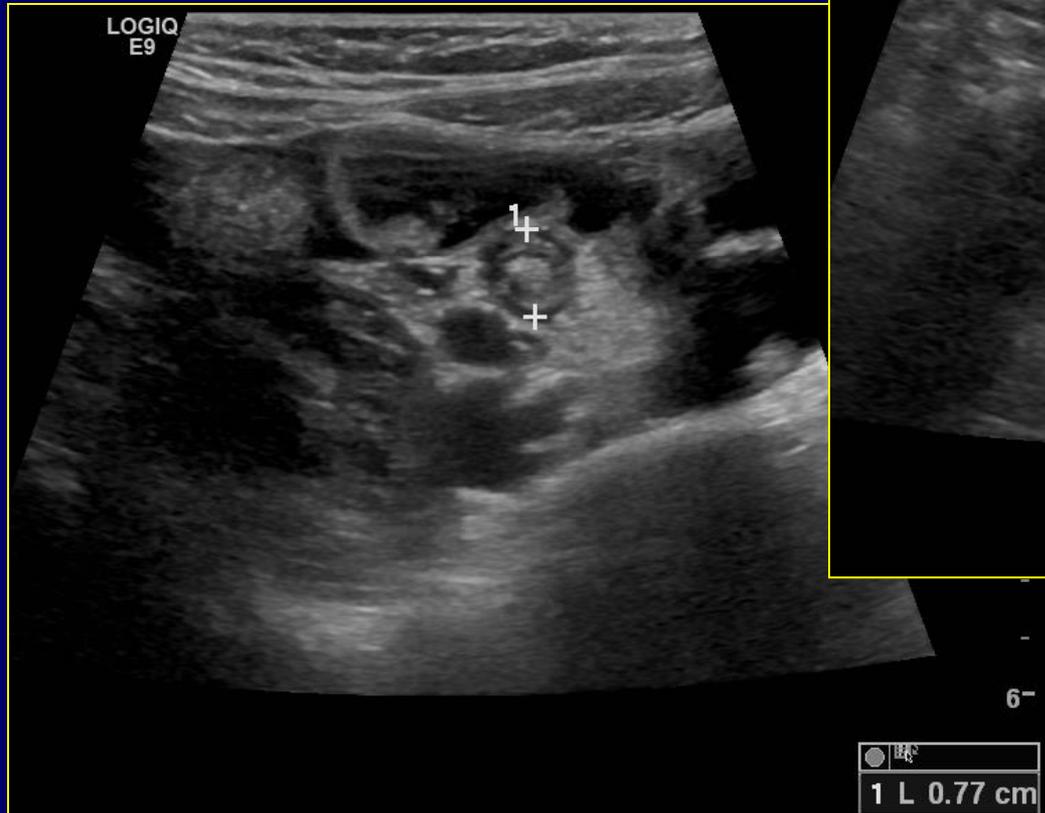
# Case 1 : Know how to measure appy.

6 yo female with VP shunt, 1 day of RLQ pain and vomiting.



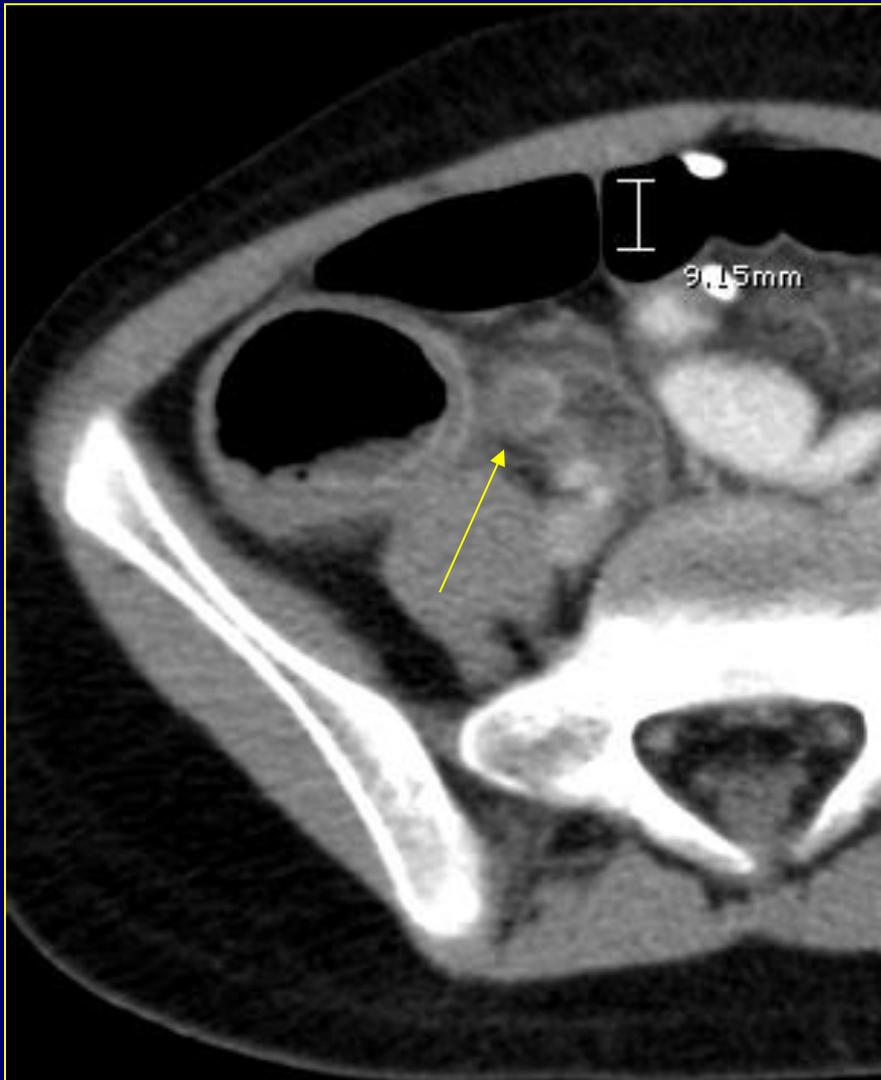
US read as:

- Borderline appendix measuring up to 7 mm diameter.
- 2. Free fluid attributed to VP shunt.



## Case 1 :

6 yo female with VP shunt, 1 day of RLQ pain and vomiting.



Since clinical exam was worrisome for appendicitis, and US was reportedly equivocal, a CT scan of abdomen was ordered.

### CT findings:

Positive appendicitis, diam 9mm  
Associated bowel wall thickening,  
free fluid and mesenteric stranding.  
(VP shunt catheter seen in midline)

## Case 1 :

6 yo female with VP shunt, 1 day of RLQ pain and vomiting.



US COULD/SHOULD HAVE BEEN read as:

- Inflamed appendix measuring up to 8 mm diameter (previously undermeasured)
- Associated mesenteric edema.

Findings are positive for appendicitis.



## Case 1 :

6 yo female with VP shunt, 1 day of RLQ pain and vomiting.



This brings us to the important question –  
**How do you measure the appendix on US?**

Answer :

The **maximum transverse diameter** of appendix is measured from **outer to outer wall**, i.e. from serosa to serosa.

> 6mm diameter is considered abnormal.

So now we must take a peek at the layers of appendiceal wall and see what they look like on ultrasound.

# Gut Signature of Appendix

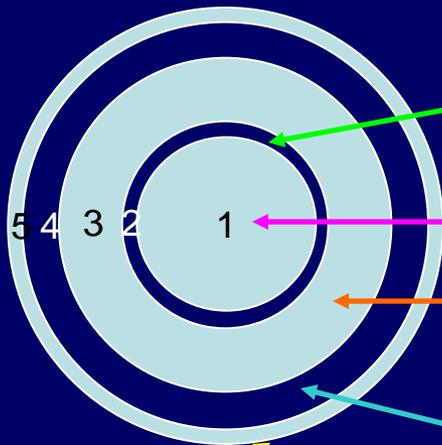


The histologic layers of appendix wall (**gut signature**) include, from innermost to outermost layer –

1. Mucosa – usually seen as central echogenic collapsed lumen
2. Muscularis mucosa - very thin hypoechoic layer surrounding mucosa
3. Submucosa – thick echogenic layer
4. Muscularis externa – thin hypoechoic muscle layer, second to last
5. Serosa – thin echogenic outermost/ last layer

# Gut Signature of Appendix

- Key:
1. Mucosa
  2. Muscularis mucosa
  3. Submucosa
  4. Muscularis externa
  5. Serosa



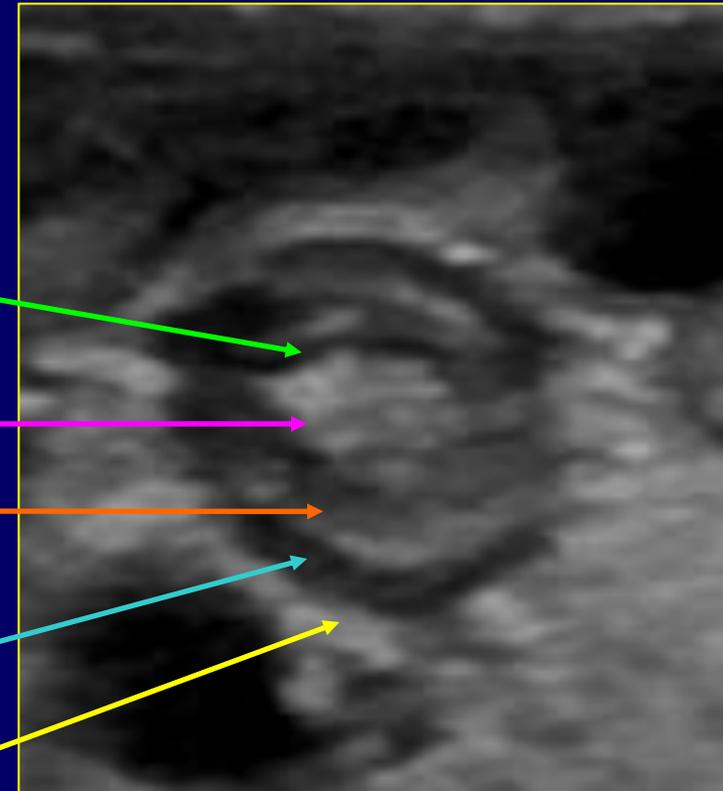
Muscularis mucosa ..

Mucosa.....

Submucosa.....

Muscularis externa...

Serosa.....



## Case 2 : Measure the maximum trans. diameter.

5 yo male with RLQ pain.



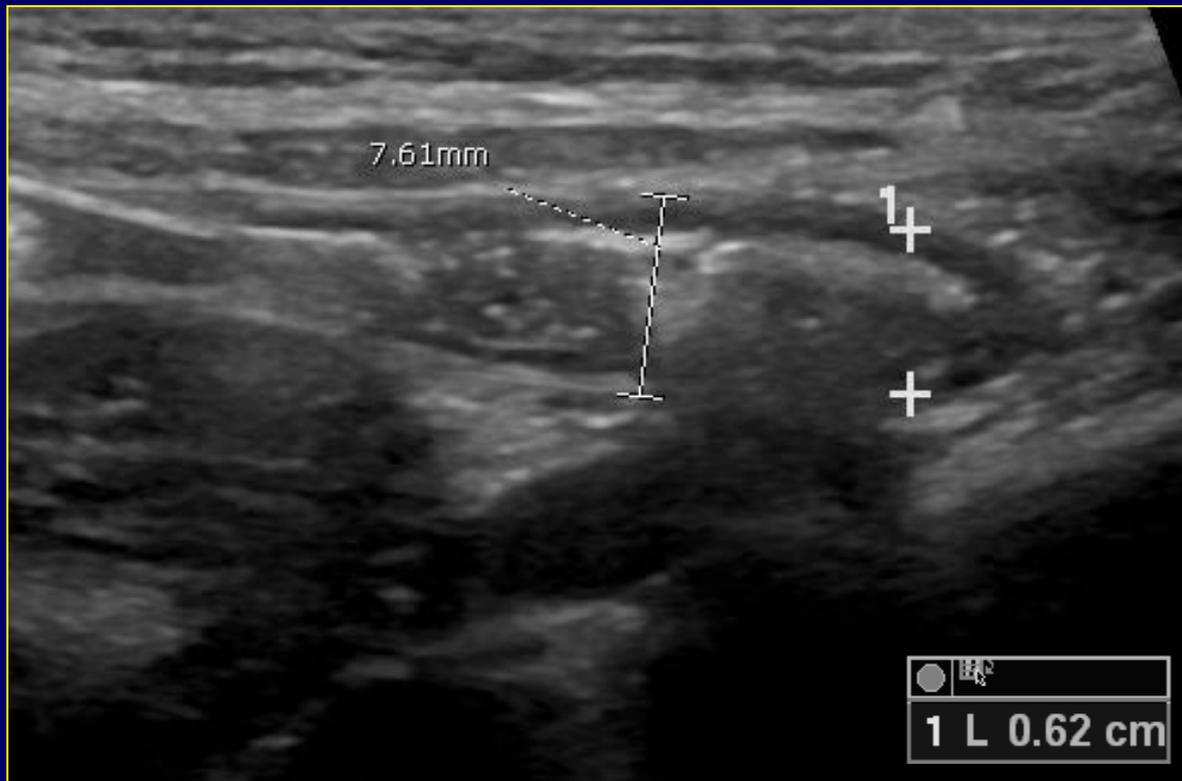
US read as:

Appy is top normal,  
diam 6.2mm.

Correlate clinically.

## Case 2 :

5 yo male with RLQ pain.



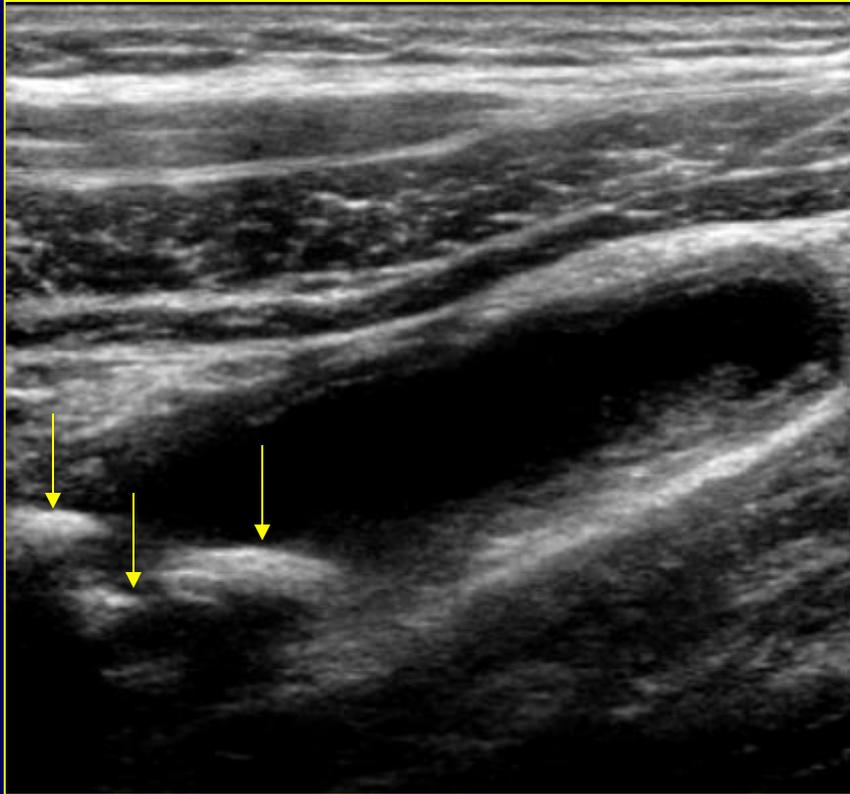
Note:  
Appy was  
undermeasured  
Initially.

US could/should have been read as:

Appy is inflamed, diam 7.6 mm with surrounding mesenteric edema,  
Positive for appendicitis.

## Case 3 : Appendicolith is trouble until proven otherwise.

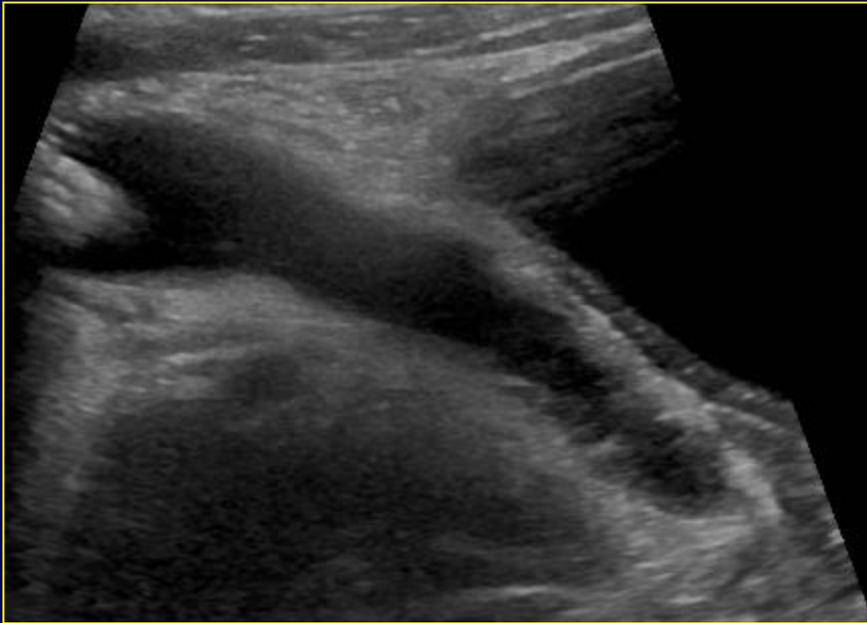
13 yo male with 2 days of RLQ pain.



US findings –

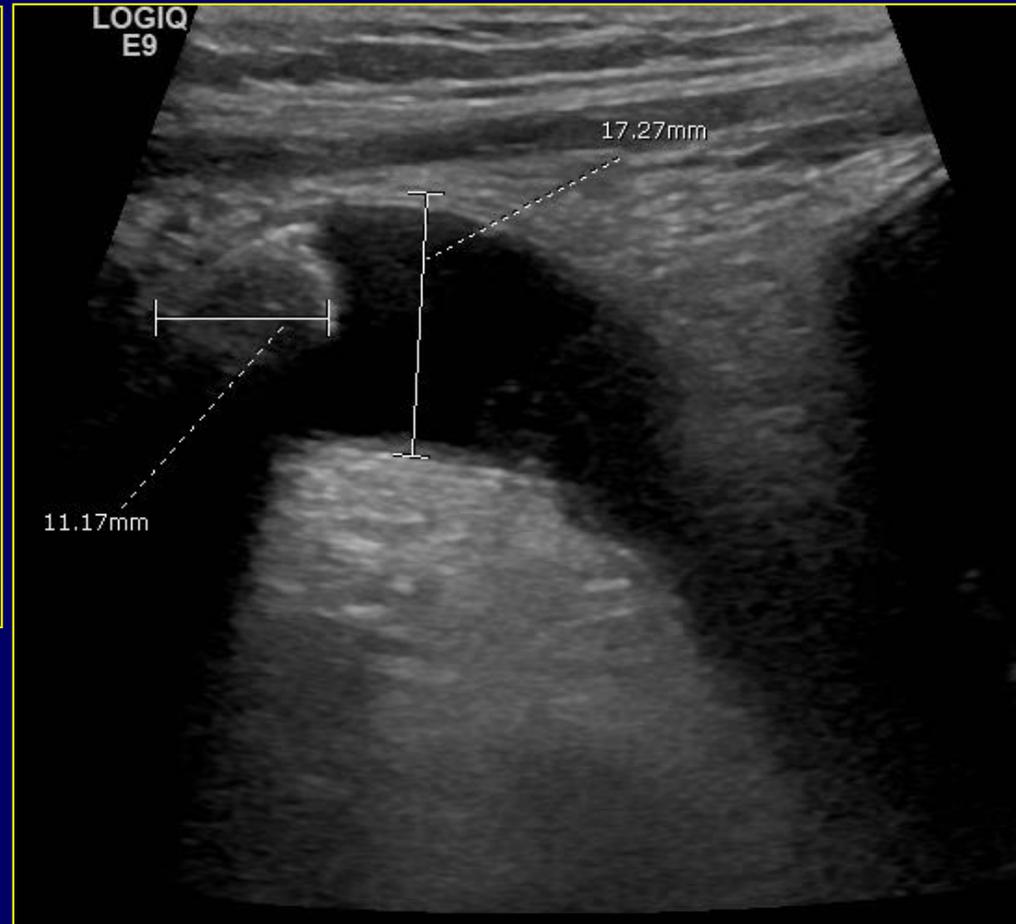
3 appendicoliths at the base of an enlarged appendix diam 17 mm.

# Case 3 : Appendicolith is trouble until proven otherwise. Companion case.



US read as : Appy not identified.

US could/should have been read as:  
17mm diam dilated appy with  
11mm appendicolith at base, positive appy.



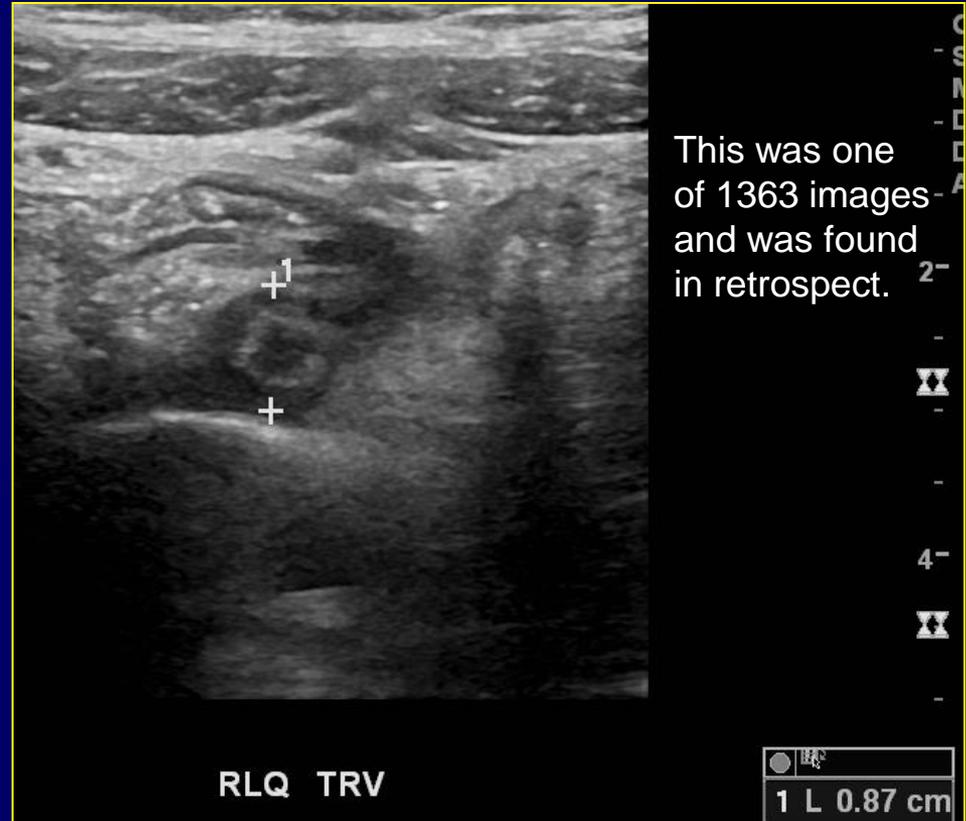
CT was the eye-opener.

# Case 4 : Appendicolith in the midst of nowhere is a strong clue to perforated appendicitis.

15 yo girl with RLQ pain, neither images nor reading of OSH CT available



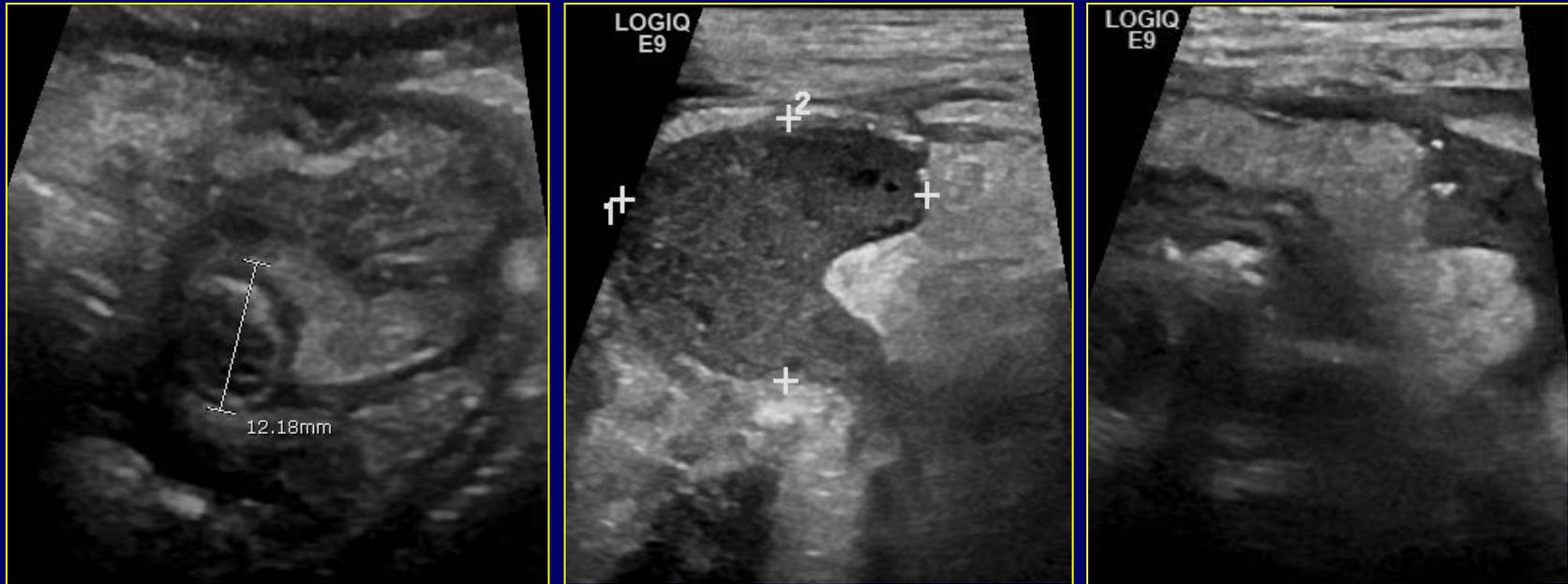
US read as equivocal, 1.3 cm shadowing structure was given a differential – calculus vs calcification vs appy'lith.



US could/should have been read as :  
Findings highly concerning for perforated appendicitis.  
(Please do not give a differential for liths in a patient with suspected appendicitis.)

## Case 5 : Look for periappendiceal abscess.

4 yo male with abdominal pain since 3 days.

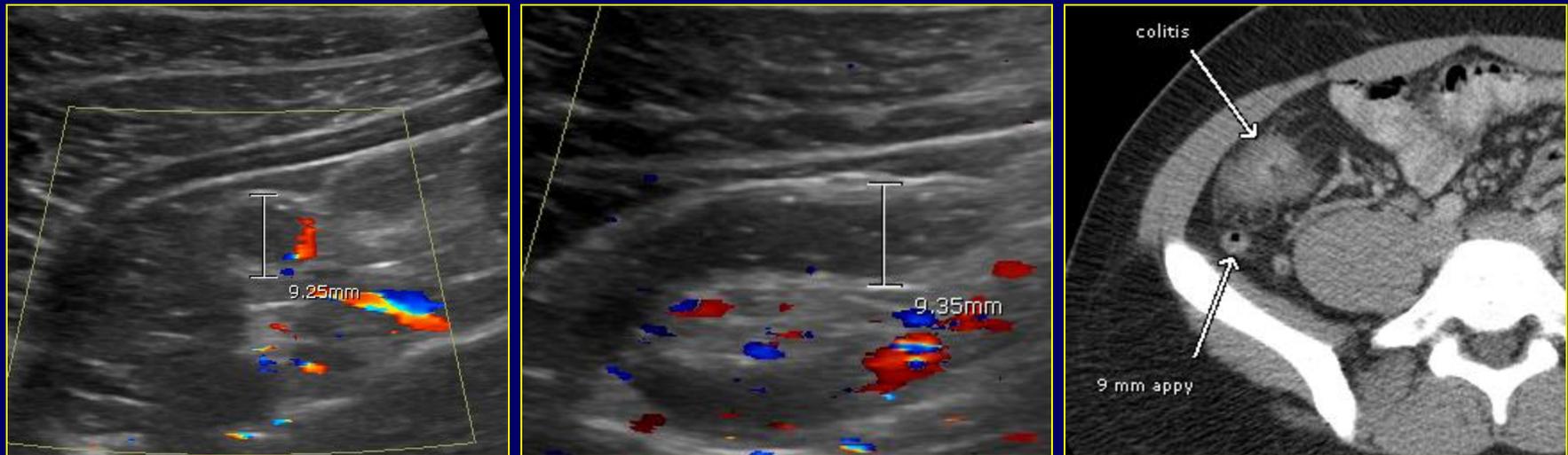


### US findings:

Appy diam.12mm with perifocal fluid collection and mesenteric edema, most consistent with ruptured appendicitis with abscess formation.

## Case 6 : Know the Appy in Crohn's scenario

4 yo male with abdominal pain since 3 days.



### US findings:

The appendix is visualized in its entire extent, diameter 9 mm however without any sonographic signs to suggest acute appendicitis. Given history of Crohn's disease, this appearance is thought to be secondary to known IBD.

CT confirmed Crohn's flare and showed an air filled appy.

## Case 7 : Know causes of false positive Appy



The appy can measure  $>6\text{mm}$  in patients with-

1. Cystic fibrosis
2. PID
3. Crohn's disease

This is considered as false positive due to reactive edema of the appy. In such cases, the appy wall thickness will be  $<2\text{mm}$  and there will be no perifocal mesenteric edema.

# Categories of Appy US Interpretation :

(In case you are wondering about the source, I got this from my right side of brain)



Appy US exams could be interpreted as follows:

1. Category 1 – Appy seen and normal
2. Category 2 – Appy not seen but no supporting signs of inflammation
3. Category 3 – Appy not seen but one or more supporting signs noted
4. Category 4 – Appy seen and abnormal

Advantages of this system –

1. US interpretation clear and uniform amongst tech and docs.
2. Helps guide next step in management,

For example, a category 1 will go home,

2 will get some observation/labs/surgical consult,

3 will get further CT

4 will go to OR/IR

# What if you do not see the appendix ?



This is either category 2 or 3.

2 is usually easy to decide clinically and is often treated conservatively.

3 is the trouble maker !

In case of 3,

1. Document as many supporting signs to suggest inflammatory pathology.
2. Start looking for other potential causes of RLQ pain such as –
  - Mesenteric adenitis
  - Intussusception
  - Meckel's diverticulitis
  - Epiploic appendagitis
  - Omental infarction
  - Enteritis/ colitis
  - Ureteral /renal colic
  - In females, check the ovaries

# US Appy Protocol



1. Focus on RLQ with linear 9 MHz probe.
2. Remember to have the bladder empty.
3. Grayscale images of – Bladder, iliac vessels, appy, bowel, psoas, nodes, GB, RK, liver, ovaries, free fluid, lung bases, & other findings.
4. Measure appy in transverse diam.
5. Cine sweep entire RLQ long and trans, with cines of pelvis/retrovesical region..

# The Challenge of Appendicitis : Take home points !



1. Know how to measure the appendix correctly. Remember the Gut Signature.
2. Measure the maximum transverse diameter, not just anywhere. Undermeasuring can lead to unnecessary CT scan.
3. Appendicolith is often trouble, until proven otherwise.
4. Appendicolith in the midst of nowhere is a clue to perforated appendicitis.
5. Look for periappendiceal abscess.
6. Know the Appy in Crohn's scenario.
7. Know causes of false positive Appy.
8. Know the Categories of US interpretation in suspected appendicitis.



Thank you