

Sonography: Paediatric Appendix

The Appendix



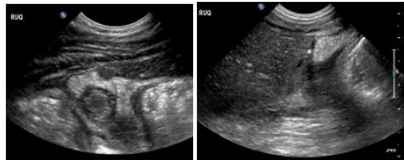
12yo Female – Perforated Appendix / phlegmon

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Overview

- Clinical Presentation
- Anatomy
- Key Messages
 - Visualisation
 - Diagnostic Criteria
 - Dispel the size myth
- Normal/ Abnormal
- Non-visualisation
 - Doesn't mean normal
- Classic pitfalls



10 yo Female – RUQ pain Appendicitis

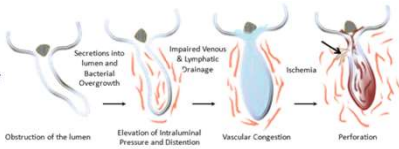
Live scan- Find the normal appendix

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Pathophysiology

- Appendiceal lumen- obstructed
 - Any part
- Increased intraluminal pressure
- Inflammation
 - Thrombosis of appendicular artery
 - Arterial insufficiency
- Resultant gangrene/ necrosis
 - Perforation
 - Bacteria invades wall




<https://epomedicine.com/medical-students/append-appendicitis-and-appendectomy/>

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Appendicitis Clinical

- Common > 5 years (Rosendahl 2004)
- Neonatal appendicitis high mortality
 - < 3 y.o.
 - Diagnosed after perforation (Nearly 100%)
- Most common surgical emergency
- Missed appendicitis
 - 2nd most common medico-legal malpractice (behind meningitis)
- Appendix ruptures
 - > 12 y.o. - 36 hrs (Klein 2007)
 - < 6 y.o. - 6 hrs




- >50% no anorexia
- >50% no migration of pain
- >50% no focal tenderness
- >50% no rebound

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Typical appendicitis: Clinical features –TBM #1

- Anorexia (likelihood ratio 1.26)
- Absence of diarrhoea (1.06)
- Pain migration (1.82)
- Guarding (1.5)
- Percussive tenderness (1.78)
- Reduced bowel sounds (2.5)
- Rovsing's sign (2.0)
- Rebound pain (1.96)
- WBC >10000/mm³ (1.89)
- One Finger, one spot
- 50% Adults, < Children... and that is my experience

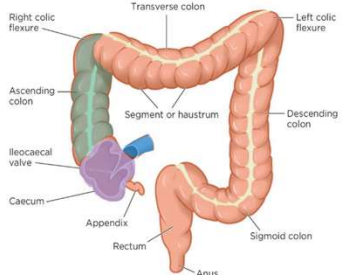


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Anatomy of the appendix

- Note the:
 - Ascending colon
 - Caecum
 - Terminal ileum
- Posteromedial aspect of caecum
- 2.5 cm inferior to ileocaecal junction



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Appendix: Surface Anatomy

- Located
 - McBurney's Point

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Appendix: Sonography

Layer 1	Superficial mucosa	Fine bright line
Layer 2	Deep mucosa	Gray
Layer 3	Submucosa	Bright
Layer 4	Muscularis propria	Dark
Layer 5	Serosa	Fine bright line

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Sonographic appearance: Appendix

- Tubular
- Blind-ending
- Aperistaltic
- Easily compressible

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Sonographic appearance: Appendix

- Tubular
- Blind-ending
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Appendix: Sonographic Anatomy

- Short
- Long axis
- How hard can it be?

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Appendix: How to visualise?

- Settings
 - Decrease frame rate
 - Decrease DR
- Transducers
 - Micro-convex
 - Linear

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Large bowel

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Sonographic appearance: Small bowel

- Presence of peristalsis
- Difficult to follow
- Mobile
- Compressible

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Appendix: The Scanning

- Rapid scanning
- Strobe the layers
- Look for the "worm"
- Small window
 - Psoas
 - Anterior abdo wall
- Why is it hard?
 - Patient tolerance
 - Position (eg gas)

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Appendix: Highly Variable Anatomy

- Highly variable
- Position
 - Note: Retrocecal
- Length
 - 1-20cm
 - Mean 11.4cm
- Need strategies

Position	Percentage
1 st : Retrocecal	43.5%
2 nd : Subcecal	24.4%
3 rd : Post-ileal	14.3%
4 th : Pelvic	9.3%
5 th : Para-cecal	5.8%
6 th : Pre-ileal	2.4%
7 th : Others	0.27%

de Souza SC, et al. Vermiform appendix: positions and length – a study of 377 cases and literature review. J. of Col 2015;35(4):212-6.

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Appendix: How to visualise?

- Retrocecal
- What can we do?
- Graded compression
 - Caecal
 - +/- rocking / fanning

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Appendix: How to visualise?

- Retrocecal
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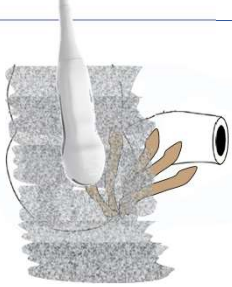
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Appendix: How to visualise?

- Retrocaecal
- What can we do?
- Graded compression
 - Caecal
 - +/- rocking / fanning
- Image-Postero-lateral
 - Prone
- Lat Decubitus
 - Fan: Lat- Medial
- Time



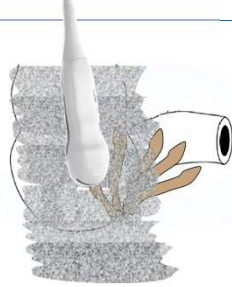
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Appendix: How to visualise?

- Retrocaecal
- What can we do?
- Graded compression
 - Caecal
 - +/- rocking / fanning

Lateral Decubitus
Image posteriorly



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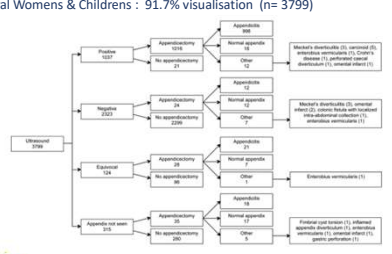
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Visualisation: The Benchmark

• Royal Womens & Childrens : 91.7% visualisation (n= 3799)



Aim: 90%


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Coady TP, Goss R, Franco-Miller C, Linko L, Linko RJ, Goh DW. Benchmarking the value of ultrasound for acute appendicitis in children. J Pediatr Surg 2016.

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Steps for visualisation

- Technique
- Mindset
- Non-visualisation
 - Normal
 - if high visualisation
 - No secondary signs
 - Monash Experience
 - Non visualisation- Not normal
 - Get a second person



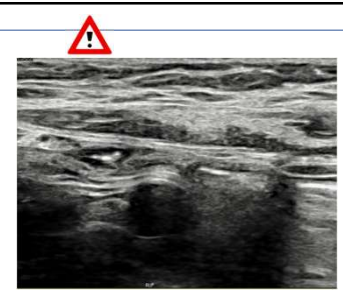
WHICH STEP HAVE YOU REACHED TODAY?

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But note ?

- Important- visualise the whole length
 - Localised inflammation
- Acquire a clip through the appendix
 - Show -arises from caecum
 - Demonstrate blind-ending
- Blind-ending not visualised
 - = Non visualisation



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US: Uncomplicated appendicitis

- > 6mm
- Focal pain
- Appendololith
- Peri-appendiceal fat
 - Hyperechoic
- Hyperaemia
- Non-compressible
- Loss of mural stratification
- No luminal gas
- Free Fluid
- Lymph nodes




Transverse view of an inflamed appendix, showing the target sign appearance and an AP diameter of 9.1 mm

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US: Uncomplicated appendicitis

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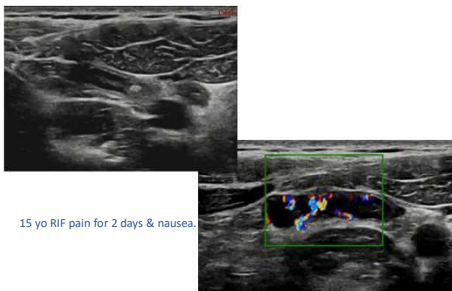
Transverse view of an inflamed appendix, showing the target sign appearance and an AP diameter of 9.1 mm

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Appendix: Criteria

- > 6mm
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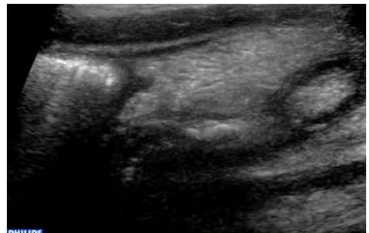
15 yo RIF pain for 2 days & nausea.

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Appendix: - What are the features?

- > 6mm
- Focal pain
- Appendololith
- Peri-appendiceal fat
 - Hyperechoic
- Hyperaemia
- Non-compressible
- Loss of mural stratification
- No luminal gas
- Free Fluid
- Lymph nodes



14yo Male - "Marked Focal Pain"

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- 12yo
- Increased BMI
- Normal/ Abnormal ?

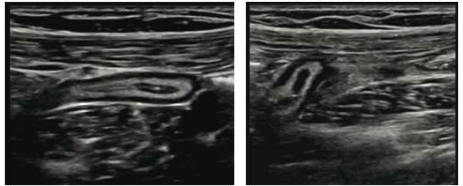


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?

- > 6mm 6.3mm
- Focal pain
- Appendololith
- Peri-appendiceal fat
 - Hyperechoic
- Hyperaemia
- Non-compressible
- Loss of mural stratification
- No luminal gas
- Free Fluid
- Lymph nodes

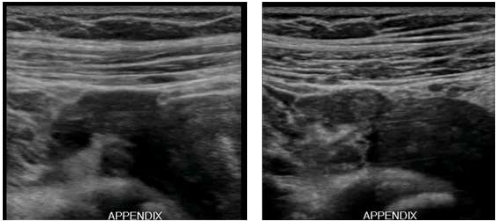


12yo female - "Moderate generalized lower abdo pain"

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?



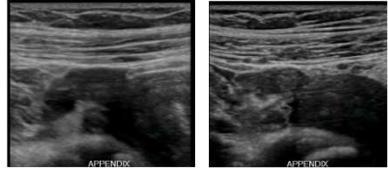
Big 8yo male – “Moderate generalized lower abdo pain”

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Criteria: Equivocal Appendix

- Equivocal
 - Not – “We aren't clever enough”
- Simply
 - If not enough signs .. “say so”



< 6mm - Normal
6-8mm - Equivocal (use secondary signs)
> 8mm - Abnormal

Trout, A. T. et al. Appendical diameter as a predictor of appendicitis in children: improved diagnosis with these diagnostic categories derived from a logistic predictive model. Eur Radiol. 2013 Aug;23(8):2211-9

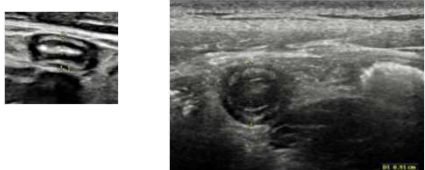
But you need to have seen it... !! – Tell a story

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US: Choose “top 3 criteria”

- Which are best?
- > 6mm
- Focal pain
- Appendolth
- Peri-appendiceal fat
 - Hyperechoic
- Hyperaemia
- Non-compressible
- Loss of mural stratification
- No luminal gas
- Free Fluid
- Lymph nodes



Transverse view of an inflamed appendix, showing the target sign appearance and an AP diameter of 9.1 mm

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Appendix: Criteria

- Primary criteria
 - Appendolth
 - Peri-appendiceal fat
- Secondary
 - Loss of mural stratification
 - Hyperaemia (Inflammation)
- Poorer predictors
 - Size
 - >6 mm
 - Non-compressible
 - No luminal gas
 - Free Fluid (+ lymph nodes)
 - No secondary signs - Normal

Effect	Odds ratio	95% confidence interval	P-value
Age (years)	1.02	0.89-1.16	0.781
Size (mm)	1.50	0.94-2.41	0.092
Loss of mural stratification	6.69	1.14-39.23	0.035
Increased wall thickness	1.86	0.69-5.83	0.285
Peri-appendiceal fat inflammation	10.04	3.06-32.92	<0.0001
Peri-appendiceal fluid: simple	0.55	0.08-3.72	0.543
Peri-appendiceal fluid: complex	0.58	0.003-132.30	0.846
Appendicolth	15.75	1.42-174.61	0.025

Searching for certainty: findings predictive of appendicitis in equivocal ultrasound exams

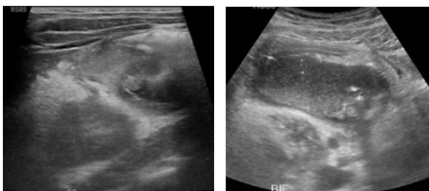
Morgan E, Etkonovich¹, Robert C. Olin², Wei Zhang³, Monica E. Lopez⁴, Jennifer L. Carpenter⁵, Nadia Mahmood¹, Siddharth P. Jadhav¹, R. Paul Gullerama¹

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Appendix: Pitfalls

- Very abnormal
 - Diffuse phlegmon/ abscess
 - Appendix not seen
- Less specific clinical stories
- Extruded appendicolth
- Careful
 - Words / History



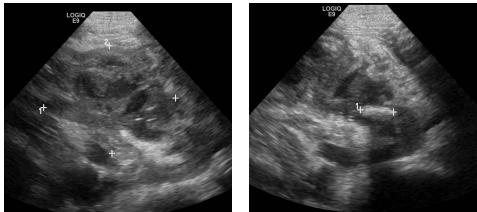
5-year-old female. 3 days fever, vomiting, diarrhoea, central colicky abdominal pain.

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Appendix: The Abnormal- Harder

- More advanced : More difficult
 - Words / History

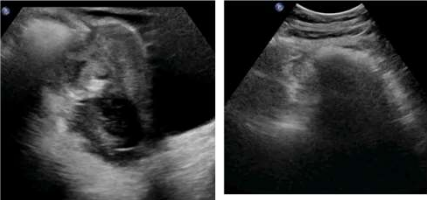


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Appendix: The Abnormal- Harder

- More advanced : More difficult
 - Perforated
 - Words / History




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Appendix: Pitfalls

- Very young



Day 1 | Day 4

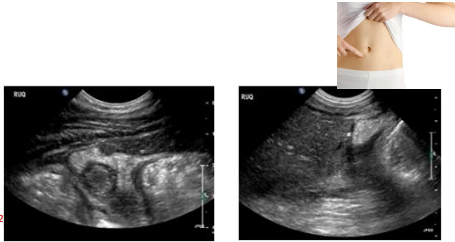
7mo colicky abdo pain, no vomiting, no blood in stools, US at "St Elsewhere" showing suspected ileocolic intussusception, ?intussusception

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Appendix: Odd positions

- 22 yo
- Clinical
 - RUQ pain, nausea & vomiting
 - ?cholecystitis
- Abdo ultrasound
 - normal GB
 - focally tender point
- 2% Appendicitis RUQ (fred 2012)
- One finger, one spot



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Appendix: The Atypical

- Atypical

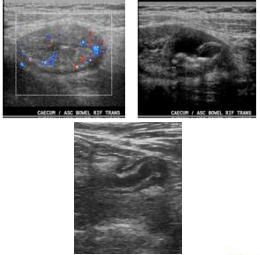


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Atypical appearance: ?

- 28 yo female
- RIF pain, dyspareunia, dysuria, discharge
- Hx appendectomy
- ?PID
- Ultrasound
- ?



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Atypical: Stump Appendicitis

- 1:50000
- Pain, nausea, vomiting
- Ultrasound appearance
 - Thickened stump, inflammation,
 - Faecoliths, FF, inflamed cecum
- < 5mm stump -> lower risk (Subramanian et al 2012)
- Treatment
 - Complicated appendicitis
 - Laparoscopic approach

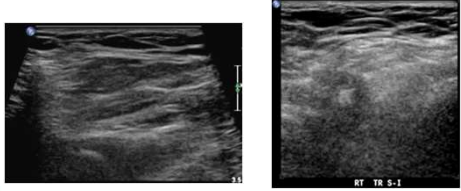


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Atypical: Amyands Hernia


- 70 yo
- Indirect Hernia- Contains normal appendix
- Appendicitis: Amyands Hernia



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34yo Female – Lower abdo pain ? Ovarian, ?Appendix

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Atypical appearance: Case Review

- Appendicele/ Appendix mucocele
- Mucous
 - Abnormal accumulation
 - Dilatation
 - Tenacious
 - Viscous
- Need to exclude malignancy
 - Eg Mucinous cystadenoma
 - Pseudomyxoma peritonei



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Mucocele of the Appendix

- Rare – 0.25% Appendectomies
- Concentric echogenic layers
- Unclear etiology
- Surgical



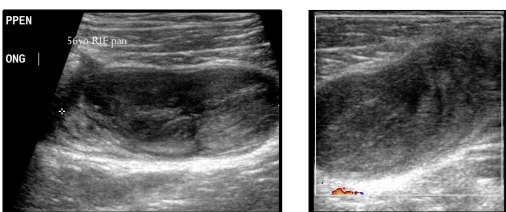
The Onion Skin Sign
A Specific Sonographic Marker of Appendiceal Mucocele

Benjamin Cassi, MD, Evan Gault, MD, Ravi Asubram, MD, Arif Herman, MD, Zari Haggag, MD, Zoi Appathurai, MD

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? Mucocele



Low grade: Mucinous carcinoma: appendix

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Acknowledgements

- Keith Van Haltren
- MH Sonographers
- Prof Michael Ditchfield



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