

DIE APPENDIZITIS AUS DER SICHT DES RADIOLOGEN

Rauscher Thomas

Institut f. bildgebende und interventionelle Radiologie

LKH Hochsteiermark, Standort Bruck/Mur



Leonid Rogozov



Selbstappendektomie
in der Antarktis 1961

Stadieneinteilung

- **Akut katarrhalisch** Hyperämie, kleine oberflächliche SH-Defekte, Granulozyteninfiltrate
- **Seropurulent** stark gerötet und verdickt, Granulozyteninfiltrat in allen Schichten
- **Ulzerophlemonös** schmiereig grau, SH-Ulzerationen, Fibrinbeläge der Serosa
- **Gangränös** Wand dunkelrot/blaurot/schwarz, brüchig
- **Ulzerös mit Perforation** Nekrose mit Austritt von App.-Inhalt
- **Perityphlitischer Abszess** DÜDA und Omentum decken Perforation
- **Perforation mit Peritonitis**

SONOGRAPHIE

Technische Voraussetzungen

Modernes Ultraschallgerät (B-Bild und Farbdopplersonographie)

=> 3.5 MHz-Konvexschallkopf (Abdomensonographie)

=> ≥ 7.5 MHz-Linearschallkopf (Darmsonographie)



SONOGRAFIE

Patientenvorbereitung/Untersuchungstechnik

Untersuchung in Rückenlage ohne besondere Vorbereitung des Patienten

Erstvorstellung mit dem Leitsymptom „Bauchschmerz“

- 1) Komplette Abdomensonographie (3.5 MHz-Konvexschallkopf)
DD akute Cholezystitis, Nierenkolik, Pankreatitis, Ileus, etc.
- 2) Darmsonographie mit dem 7.5 MHz-Linearschallkopf
 - Systematischer Untersuchungsablauf: Kolonrahmen und terminales Ileum
 - Punktuelle Untersuchung (Duodenum/Jejunum/Ileum)
 - Gezielte Untersuchung nach Schmerzlokalisierung

WICHTIG: Konsequente graduelle Kompression!

SONOGRAFIE

Sonoanatomie: Leitstrukturen erkennen!

Orientierung im Unterbauchquerschnitt: **Mit dem 3.5 MHz-Konvexschallkopf beginnen** und Leitstrukturen aufsuchen:

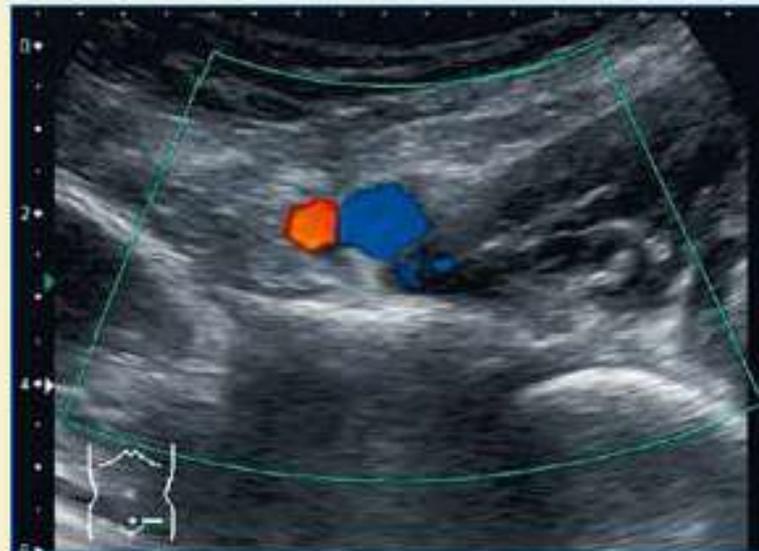
Harnblase => Iliakalgefäße => M. Psoas/ossäre Beckenstrukturen (Femurkopf/Os Ileum)
=> danach mit dem hochfrequenten Linearschallkopf (Bildfeld anpassen!)

*Querschnitt linker Unterbauch
3.5 MHz*

*Links:
Harnblase*

*Rechts:
Dorsal Femurkopf
(echoreicher Kuppenreflex)
Ventral M. psoas (echoarm)*

Bildmitte: A.IV. iliaca externa



SONOGRAFIE

Aufsuchen: Coecum/rechtsseitiges Kolon



Kontinuierliche Untersuchung des **Kolonrahmens** vom rektosigmoidalen Übergang bis zum Coecum (nicht komplett einsehbar sind das Rektum und der Bereich der Flexuren)



Coecum quer



Coecum längs – freie Flüssigkeit (Pfeil)

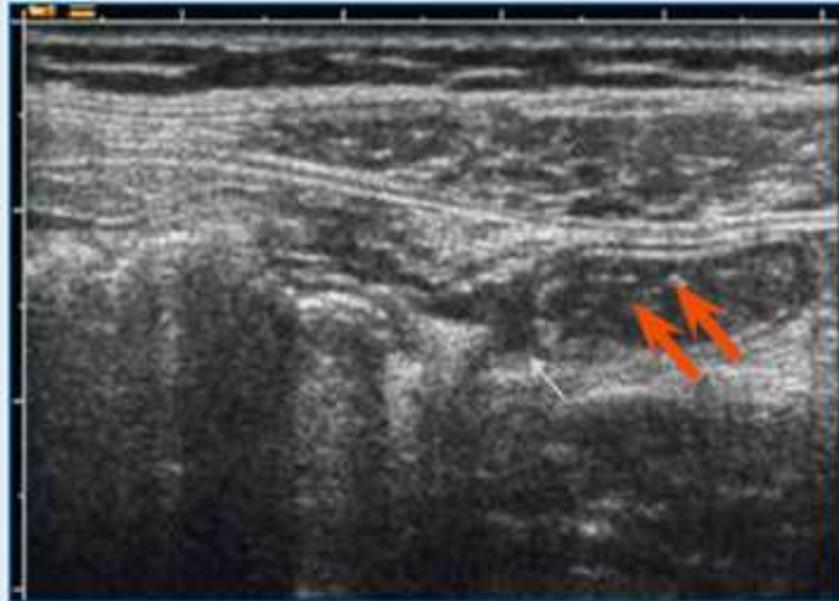
Cave! Die Lage des Coecum ist variabel in Höhe der Spina iliaca ant. sup., aber auch weiter kranial z.B. in Höhe des rechten Rippenbogens

SONOGRAFIE

Aufsuchen: Terminales Ileum



Im Unterbauchquerschnitt rechts die Iliakalgefäße neben der Harnblase in der Bildmitte zentrieren, zum Auffinden des terminalen Ileums Schallkopf unter kontinuierlicher Kompression nach kranial verschieben bis zum terminalen Ileum (rote Pfeile) (Peristaltik!)



SONOGRAFIE

Aufsuchen der Appendixregion



Bei typischer Lokalisation (cave Lagevariabilität!) verläuft der Appendix von seinem Abgang vom Coecum deutlich kaudaler als das terminale ileum auf dem M. psoas und erreicht in seinem Verlauf die Iliakalgefäße.

=> Der Appendix (Pfeile) weist im Gegensatz zum terminalen Ileum keine Peristaltik auf!



SONOGRAFIE

Normalbefund Appendix

Außendurchmesser < 6 mm
Fehlende Peristaltik
Abgang aus dem Coecum kaudal des term. Ileums
Drei- bis Fünfschichtung
Blindes Ende

*Normaler Appendix (Pfeile)
In typischer Lage
Ventral auf dem M. psoas*

*Rechts im Bild:
Iliakalgefäße*



SONOGRAFIE

- App-DM $>6\text{mm}$ ($>7\text{mm}$), Darmwand verbreitert ($>2\text{mm}$)
- Komprimierbarkeit
- Appendikolith
- Doppler: verstärkte Durchblutung; Gangrän –
- Freie Flüssigkeit, hyperechogene Umgebungsreaktion
- Lokoregionäre, vergrößerte LNN
- DS im rechten UB bei Untersuchung

SONOGRAFIE



Tab. 1 Literaturübersicht zur transabdominellen Ultraschalldiagnostik der akuten Appendizitis (Metaanalyse bezogen auf 8 Studien = Carroll et al.).

Studie	n = Anzahl der Patienten	Sensitivität in %	Spezifität in %
Nasiri et al. 2012 [14]	75	71,2	83,3
Carroll et al. 2012 [15]	1268	92	96
Al Ajerami et al. 2012 [16]	180	84,8	83,3

On the Role of Ultrasonography and CT Scan in the Diagnosis of Acute Appendicitis

Jyotindu Debnath, Rajesh Kumar, Ankit Mathur, Pawan Sharma, Nikhilesh Kumar, Nagaraj Shridhar, Ashwani Shukla, and Shiv Pankaj Khanna

Abstract

Go to: 

The purposes of this study were to revisit the utility of ultrasonography (USG) as a primary imaging modality in acute appendicitis (AA) and to establish the role of CT scan as a second-line/problem-solving modality. All cases of suspected AA were referred for urgent USG. USG was done with standard protocol for appendicitis. Limited computed tomographic (CT) scan [NCCT ± CECT (IV contrast only)] was done for the lower abdomen and pelvis where sonographic findings were equivocal. One hundred and twenty-one patients were referred for USG for suspected appendicitis. Eight-four patients underwent surgery for AA based on clinical as well as imaging findings, of whom 76 had appendicitis confirmed at histopathology. Three patients were misdiagnosed (3.6 %) on USG as appendicitis. Of 76 patients of appendicitis confirmed histopathologically, 63 (82.8 %) had features of appendicitis on USG and did not require any additional imaging modality. Of 121 patients, 12 (10 %) needed CT scan because of atypical features on USG. Of these 12 patients, seven had retrocecal appendicitis, and three high-up paracolic appendicitis. USG alone had sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and accuracy of 81, 88, 92.6, 71.6, and 83 %, respectively. When combined with CT scan in select cases, the sensitivity, specificity, PPV, NPV, and accuracy of combined USG + CT scan were 96 % ($P=0.0014$), 89 %, 93 %, 93.5 % ($P=0.0001$), and 93 % ($P=0.0484$), respectively. Twenty-eight (23 %) patients were given alternative diagnosis on USG. Dedicated appendiceal USG should be used as a primary imaging modality in diagnosing or excluding AA. Appendiceal CT can serve as a problem-solving modality.

- US allein: 81, 88, 92.6, 71.6 – 83%

- US + CT: 96, 89, 93, 93.5 - 93%

Conclusion

Go to: 

In the era of ever-increasing usage of CT scan as a primary imaging modality for diagnosing AA, we still find dedicated appendiceal USG very useful in diagnosing or excluding AA, and hence, USG should be used as the primary and frontline imaging modality for diagnosing AA. Appendiceal CT would be best used as a second-line/problem-solving modality in view of its radiation burden.

COMPUTERTOMOGRAFIE

Fehlen von mind. 1 klassischen Zeichen:

Fieber

Wanderschmerz

McBurney

Labor

oder

V.a. Perforation

COMPUTERTOMOGRAFIE

- DM >6mm (>7mm)
- Streifige Infiltration des periapp. Fettgewebes
- Verdickung > 2mm + KM-Aufnahme der Wand
- Zökumwand apikal breiter ggü. C.ascendens
- Appendikolith, extraluminal Fl. oder Gas
- Abszess

Appendiceal diameter: CT versus sonographic measurements

Authors

[Authors and affiliations](#)

Emily S. Orscheln, Andrew T. Trout 

Results

We reviewed exams of 155 children (58.7% female) with a mean age of 11.3 ± 4.2 years; 38 of the children (24.5%) were diagnosed with appendicitis. The average time interval between US and CT was 7.0 ± 5.4 h. Mean appendiceal diameter measured by CT was significantly larger than that measured by US in cases without appendicitis (5.3 ± 1.0 mm vs. 4.7 ± 1.1 mm, $P < 0.0001$) and in cases with appendicitis (8.3 ± 2.2 mm vs. 7.0 ± 2.0 mm, $P < 0.0001$). Mean absolute diameter difference at any location along the appendix was 1.3–1.4 mm in normal appendices and 2 mm in cases of appendicitis.

Conclusion

Measured appendiceal diameter differs between US and CT by 1–2 mm, calling into question use of the same diameter cut-off (6 mm) for both modalities for the diagnosis of appendicitis.

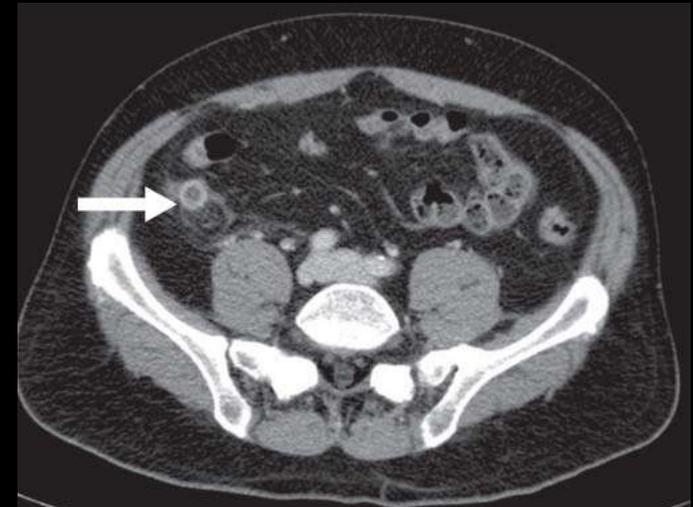
1 – 2 mm Differenz
zwischen CT und
US

Berechtigte Frage:
Warum gleicher
Cut Off Wert von
6 mm?

COMPUTERTOMOGRAPHIE

Untersuchungsparameter	Niedrigdosis- technik-CT	Standarddosis- technik-CT
rekonstruierte Schichtdicke in mm	3	3
Röhrenspannung in KV	100	120
Röhrenstrom in mAs/Schicht	80	250
Kollimation in mm	2 × 128 × 0,625	2 × 128 × 0,625
Pitch	0,985	0,985
Rotationszeit in s	0,33	0,33
mittleres FOV in mm	350	350
Fenster	60 – 340	60 – 340
CTDI in mGy	5,7	9,8
mittleres DLP in mGy × cm	233	575

Studie	n = Anzahl der Patienten	Sensitivität in %	Spezifität in %
Kim et al. 2012 [21]	440 SD iv	95,0	93,8
	433 ND iv	94,5	93,3
Seo et al. 2009 [30]	207 SD iv	100/100	93/96
	207 ND nativ	98/100	95/96
Kim et al. 2011 [29]	44 SD iv	89	89
	55 ND iv	90	90
Platon et al. 2009 [31]	86 SD iv	100/100	98/98
	86 ND o	100/100	98/98



PROBLEME BEI DER DIAGNOSE – PITFALLS IN CT UND US: GIBT`S NICHT, ODER?

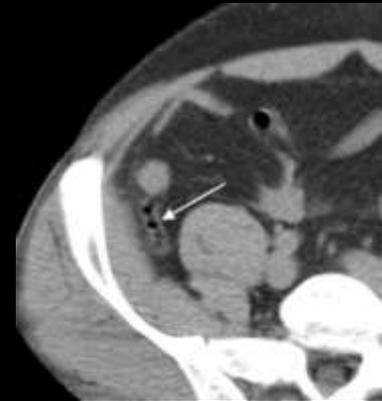
App. acuta



Perf. App

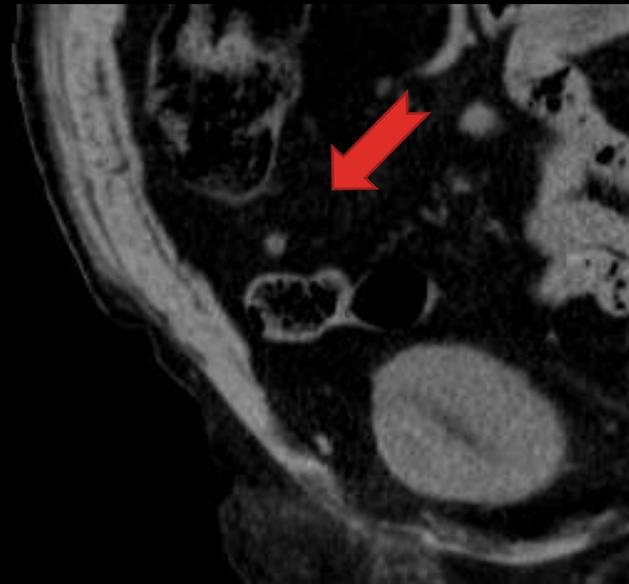


Normale
Appendix



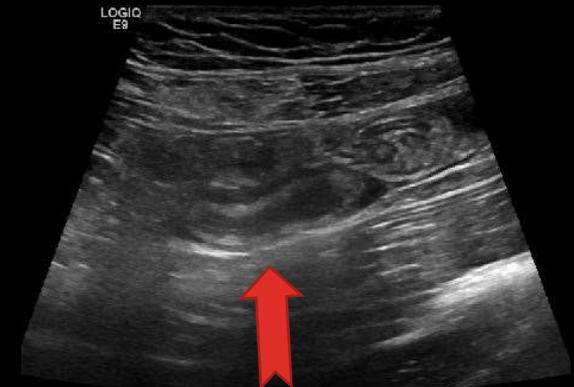
1. KÖRPERBAU DES PATIENTEN

- intraabdominelles Fett
- CT und US komplementär



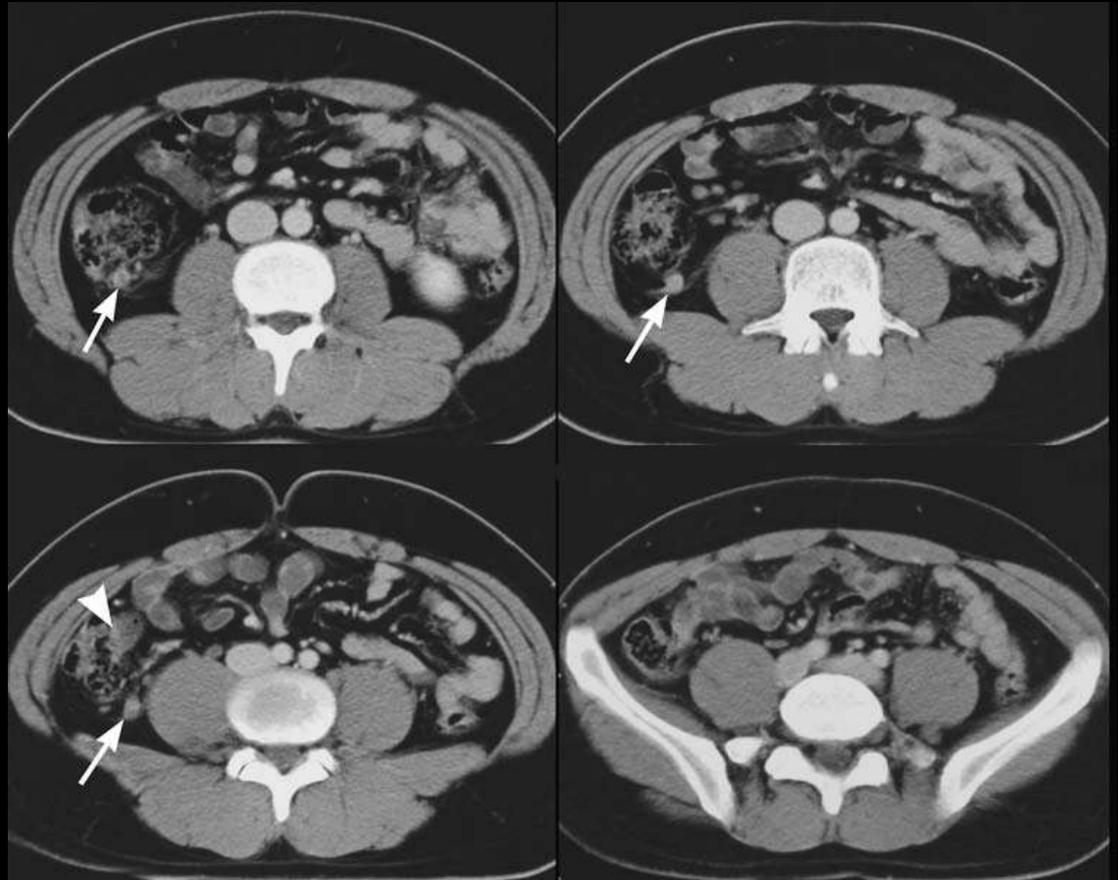
1. KÖRPERBAU DES PATIENTEN

- intraabdominelles Fett
- CT und US komplementär



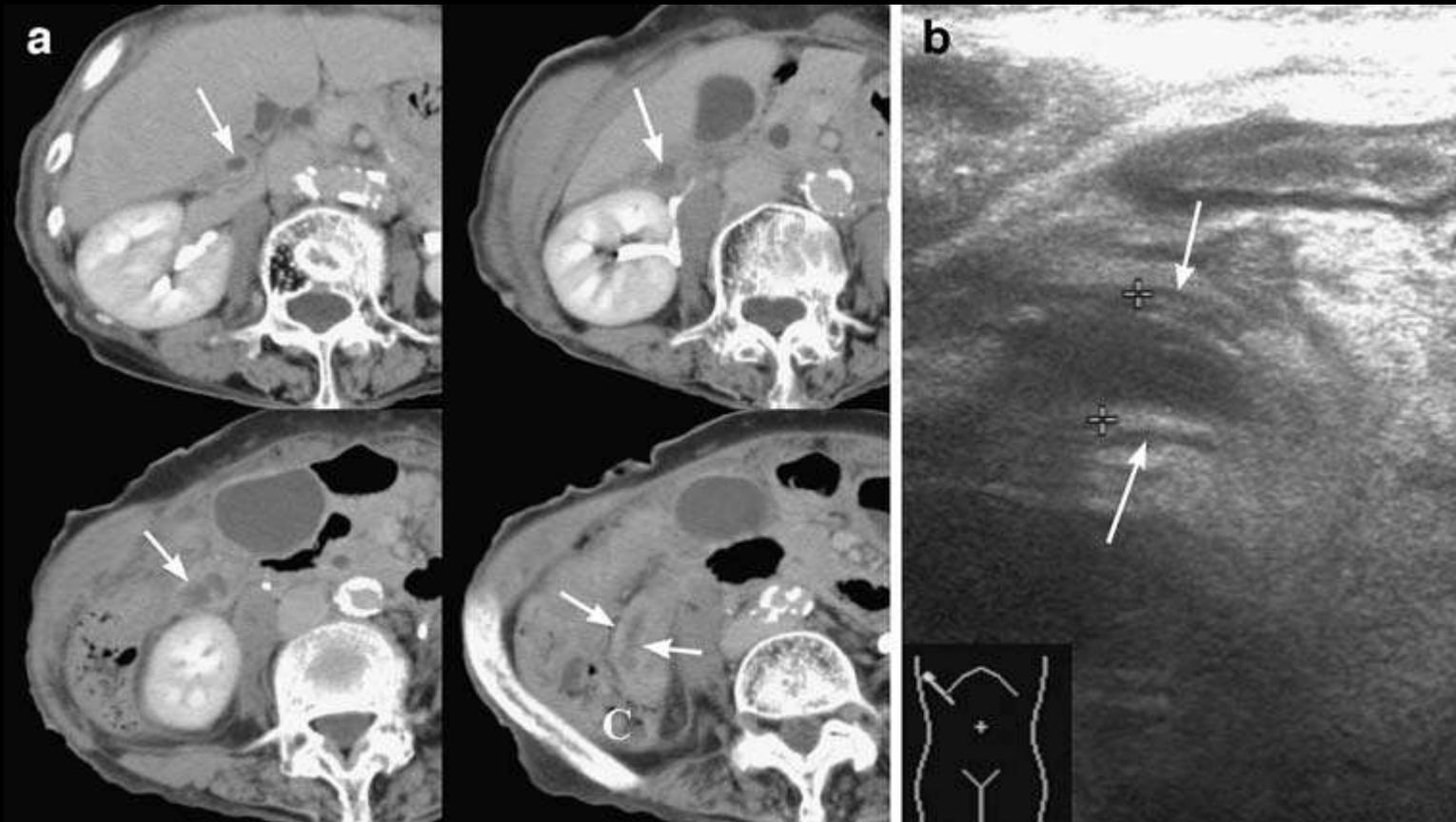
2. RETROZÖKALE LAGE

- 26% - 65%
- Atypische Klinik (Oberbauch, Flanke)
- Komplikation
- CT > US



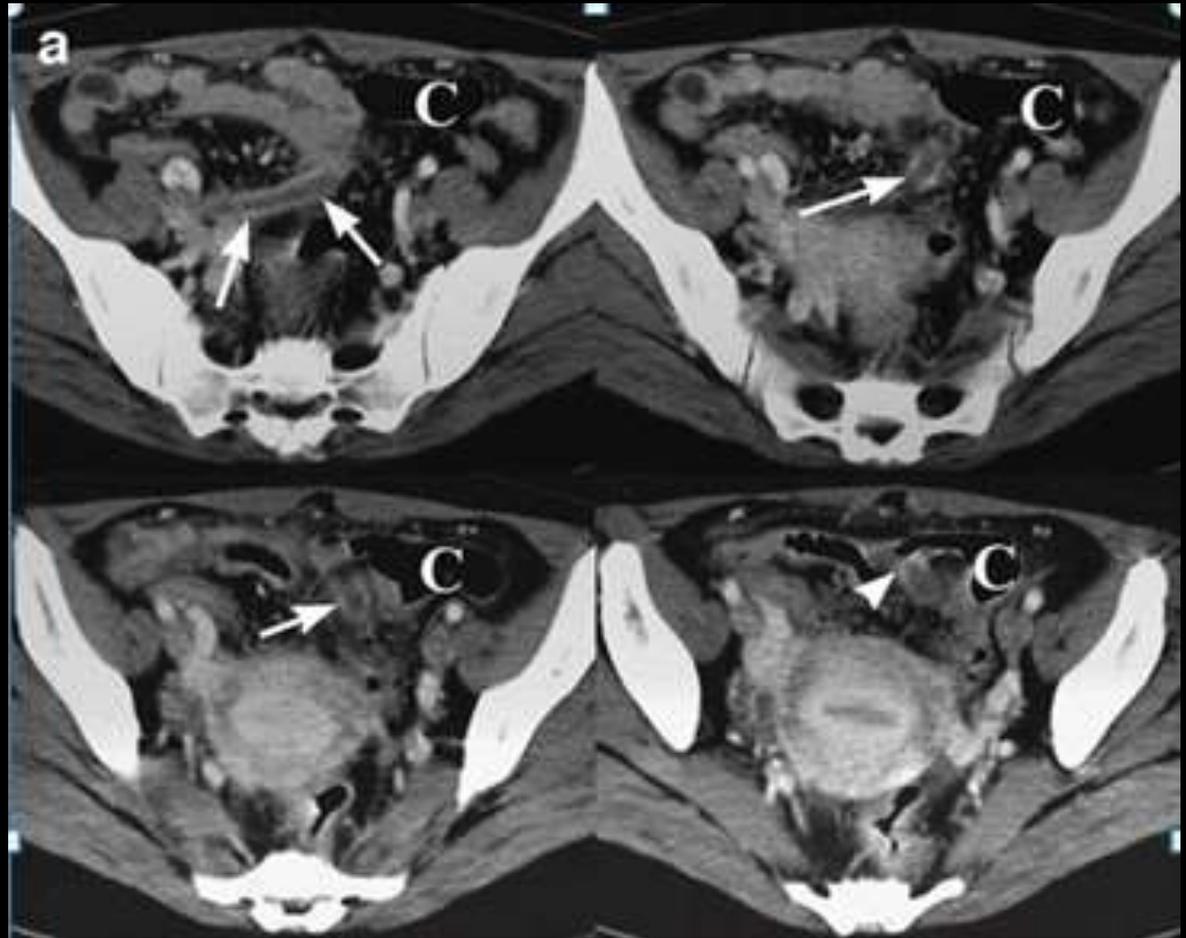
3. MORISON POUCH

- Schmerzen im Oberbauch – Ursache?



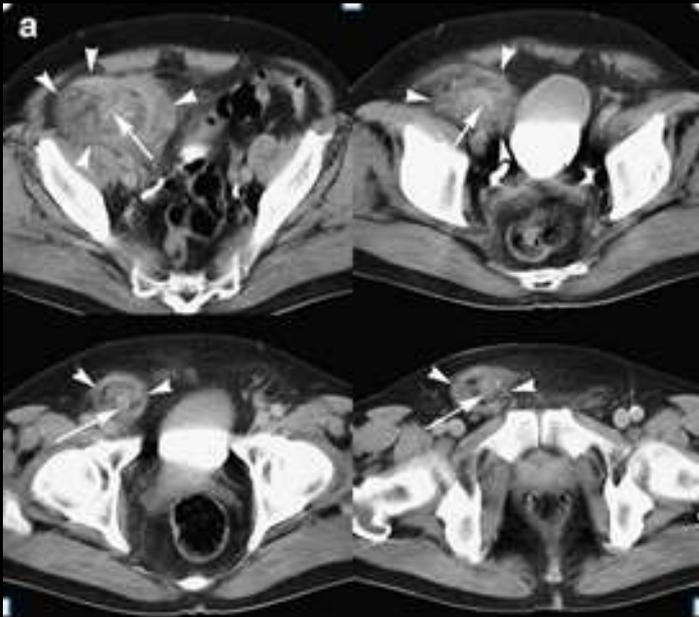
4. APP + UNTYPISCHE ZÖKUMPOSITION

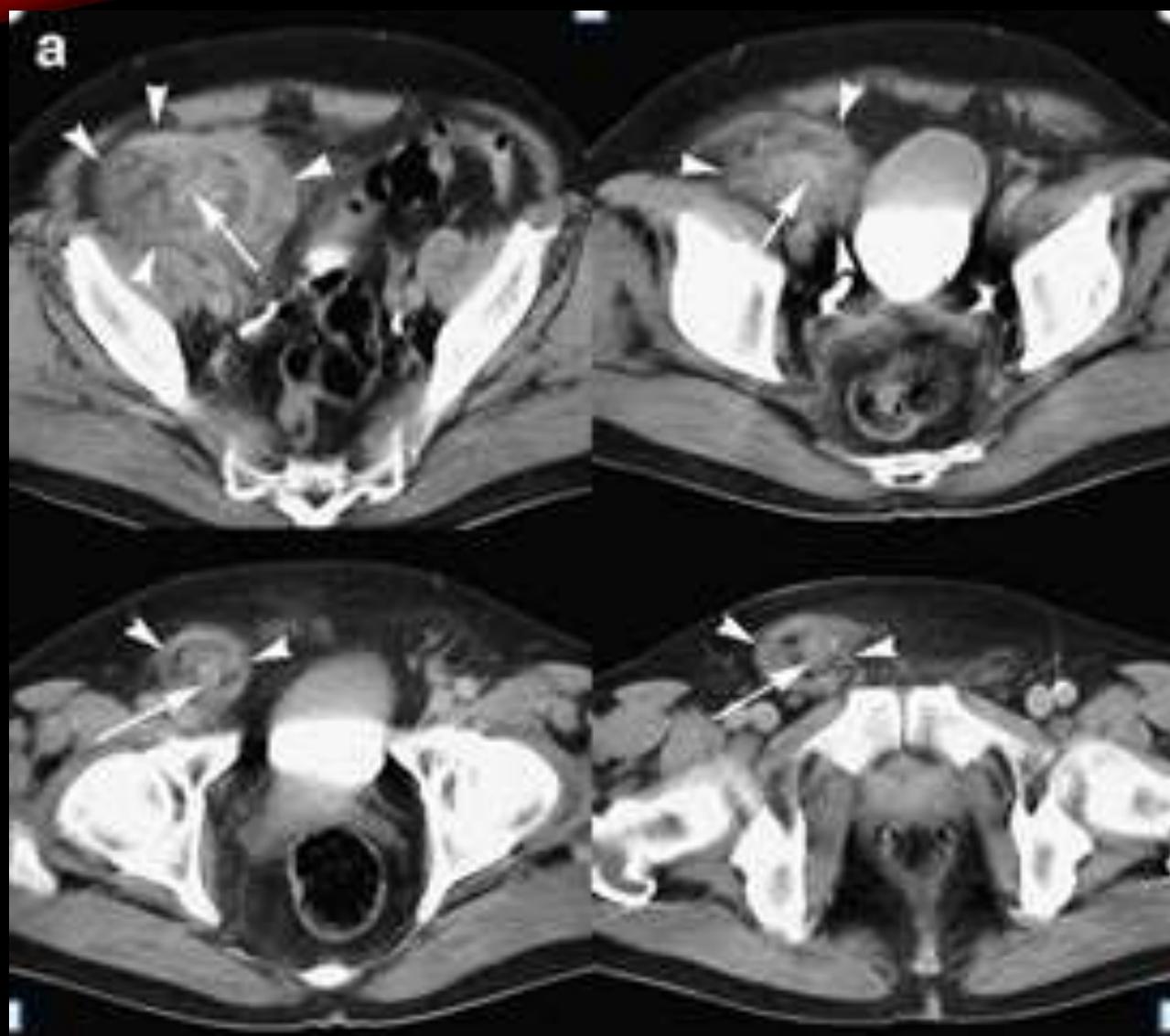
- C.asc u Zökum:
11% mobil



5. APP + INGUINALHERNIE

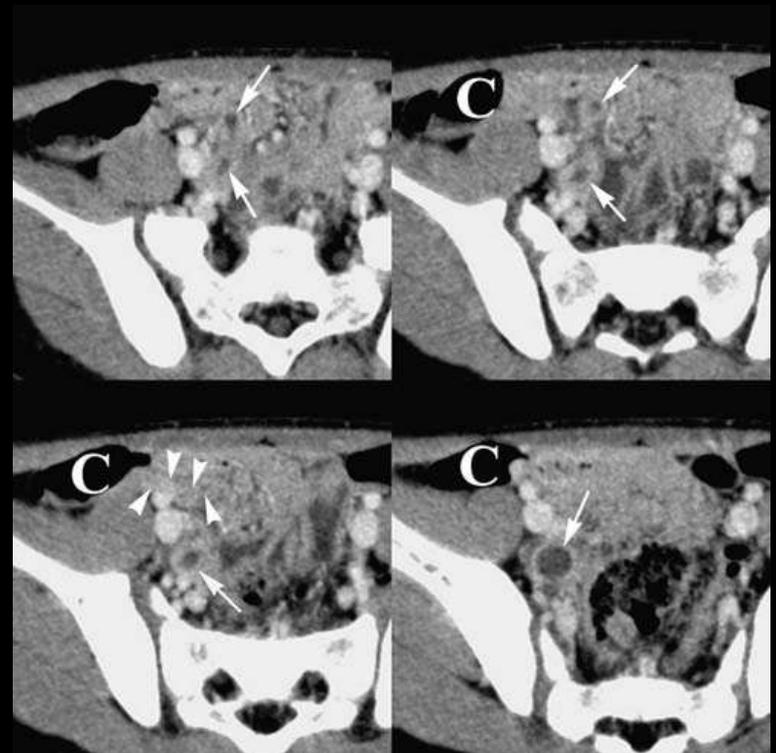
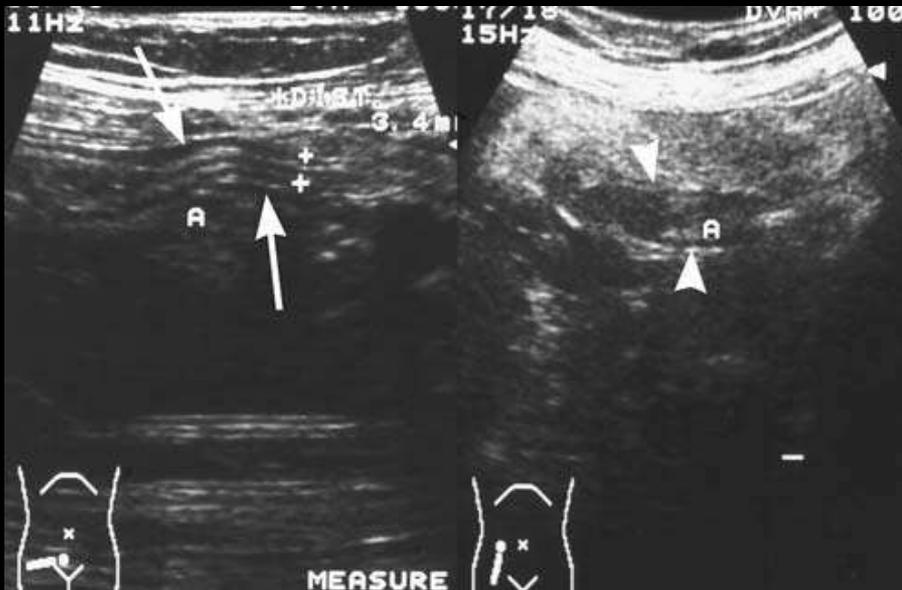
- **AMYAND**-Hernie (0,13%),





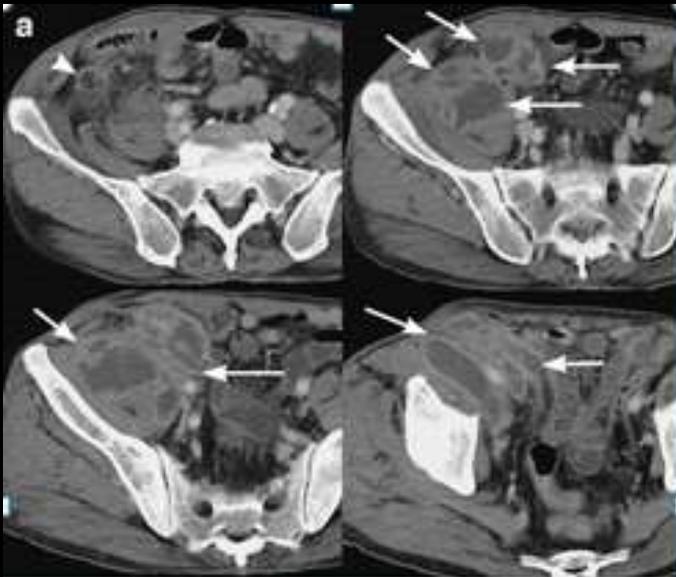
6. DISTALE APPENDIZITIS

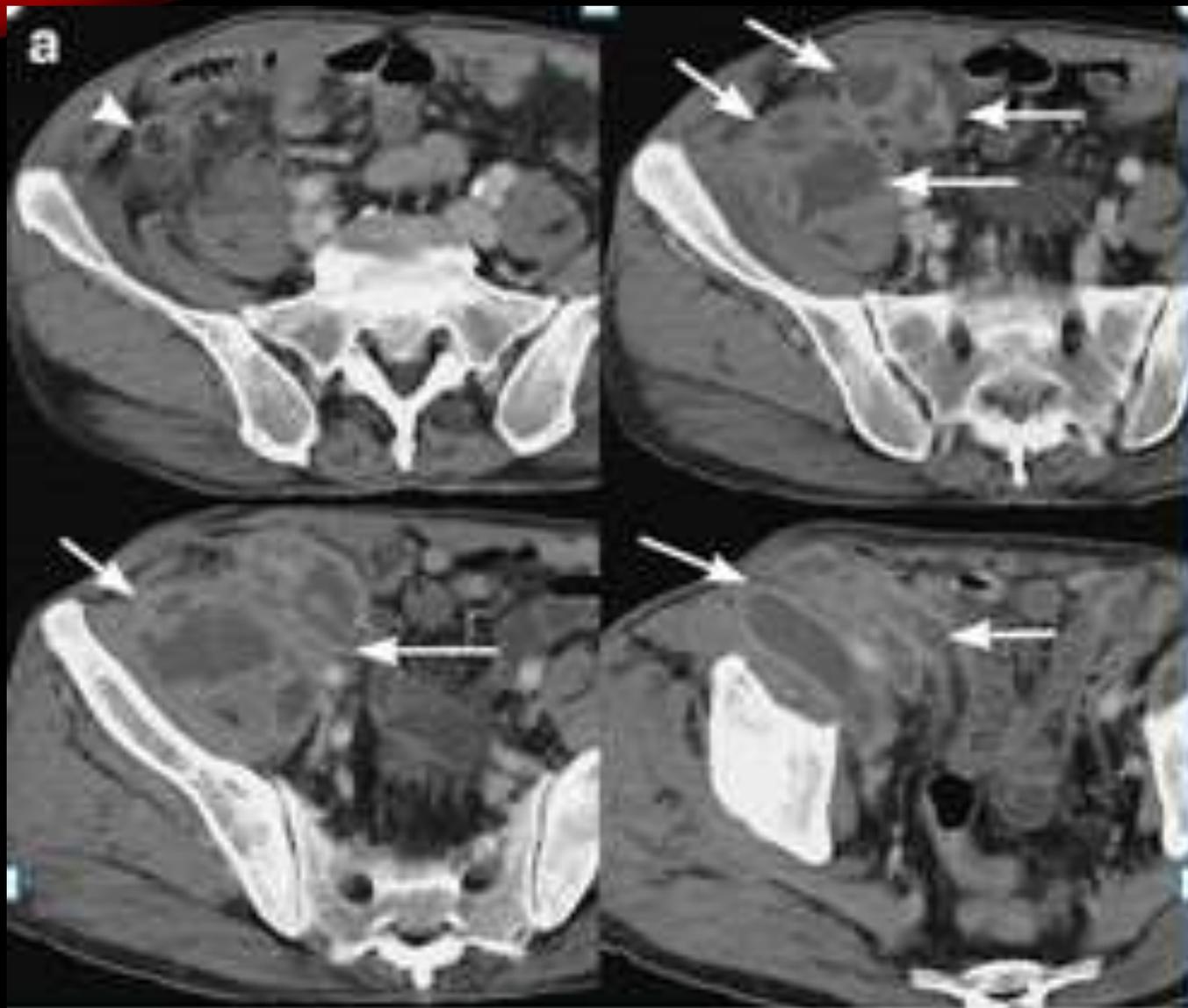
- Entzündung nur an der freien Spitze
- Darstellung in gesamter Länge notwendig



7. PERIZÖKALER ABSZESS

- Perforation : Phlegmon +/- Abszess
- CE-CT / US: Darstellung von App.-Wand +/- Appendikolith im Abszess





8. VERWECHSLUNG VON APP. UND DÜDA

Appendix

- Zökumbasis
- Blindes Ende
- Keine Peristaltik
- rund

Terminales Ileum

- Zökum medial
- Kein blindes Ende
- Peristaltik (?)
- dreieckig

Vermeidung durch KM intraluminal (per os/rektal)

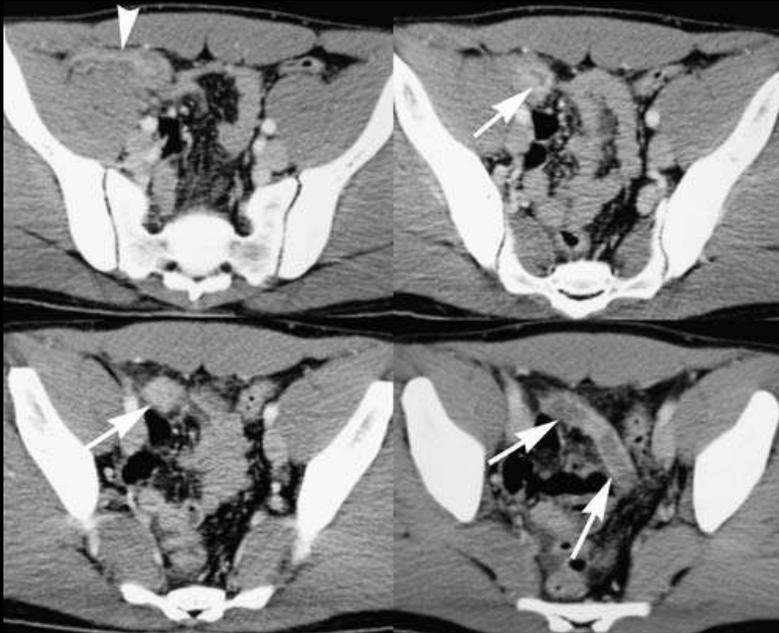
8. APPENDIX ODER DÜNNDARM



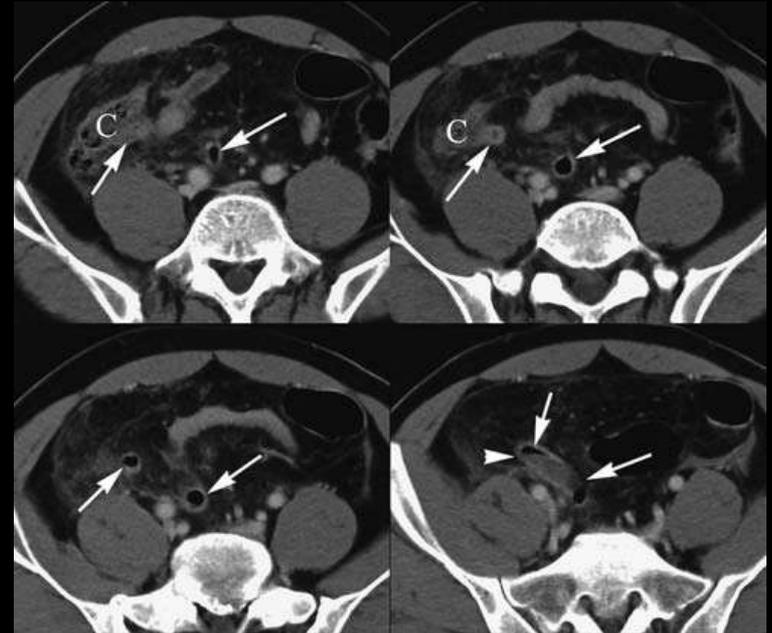
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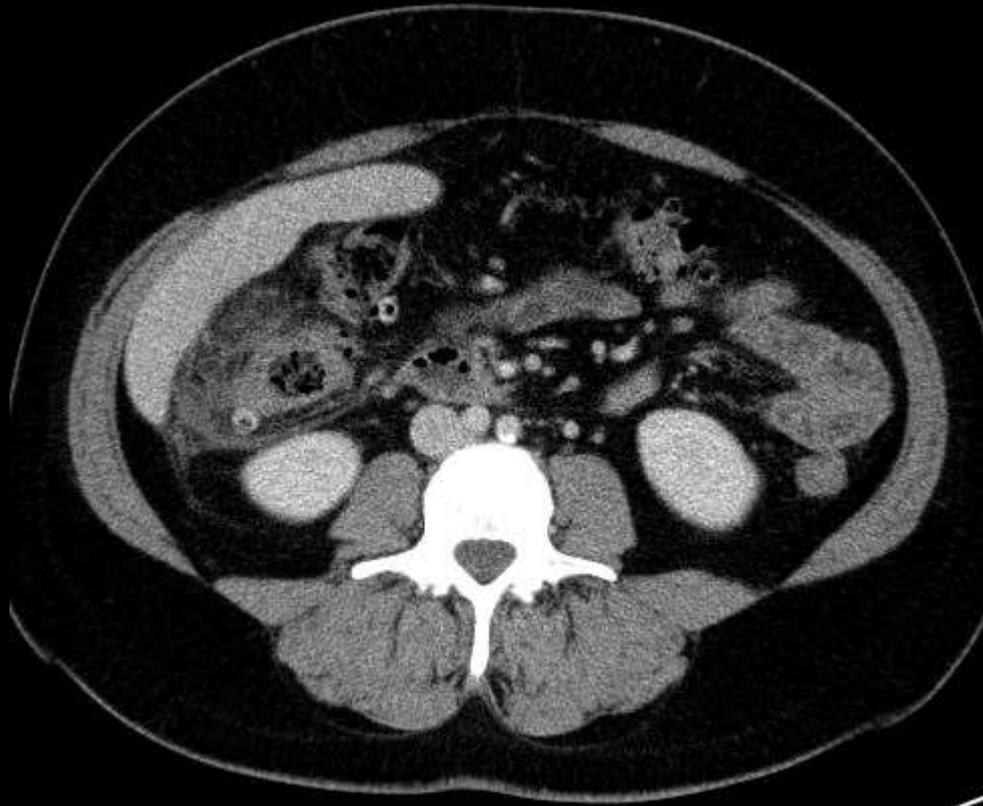
8. APPENDIX ODER DÜNNDARM



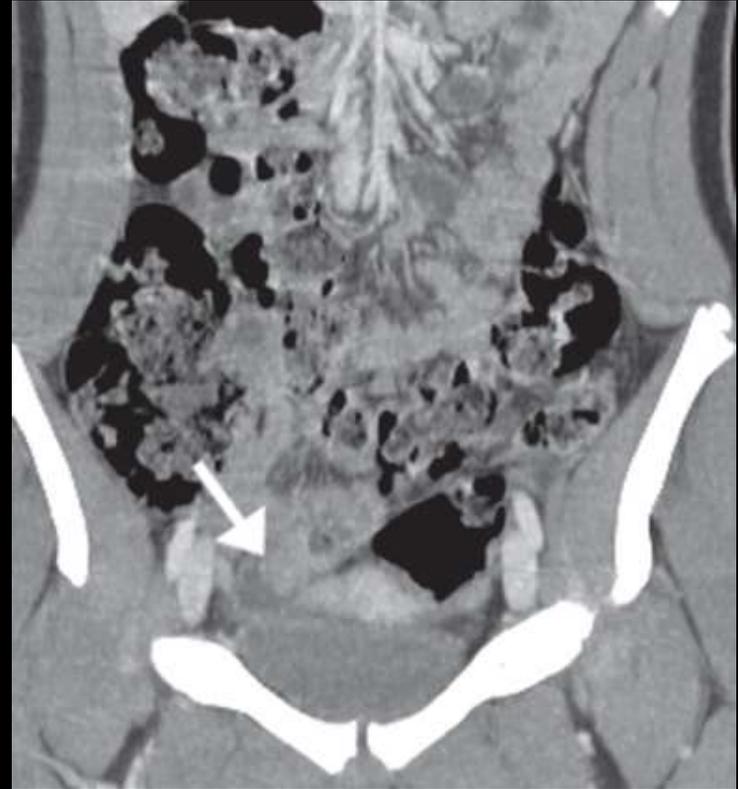
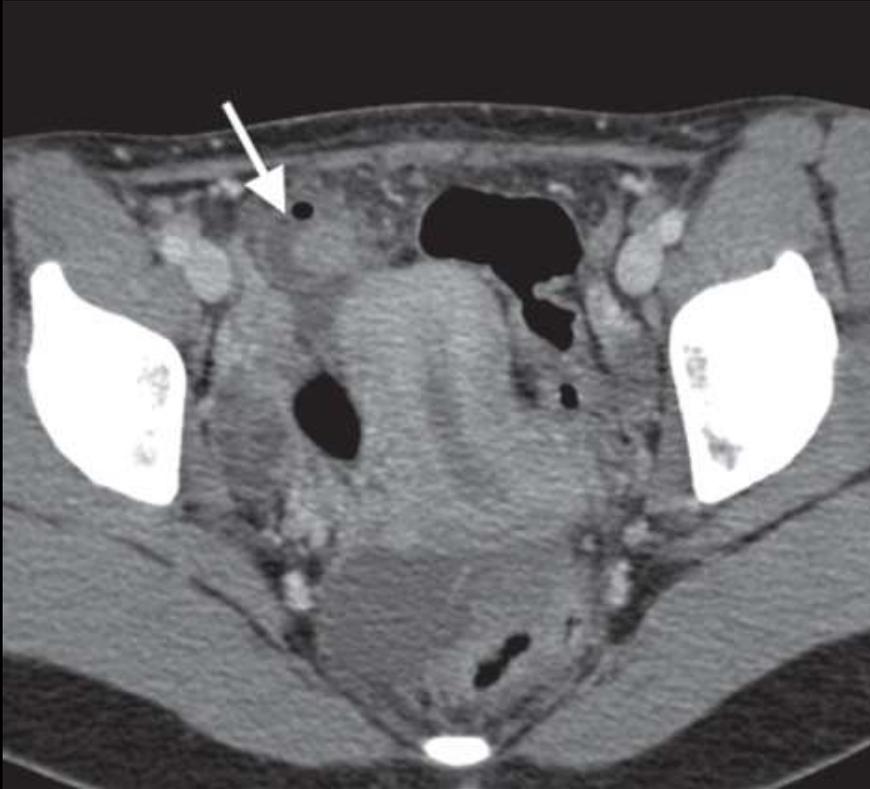
?



9. RECHTSSEITIGE KOLONDIVERTIKULITIS



10. MECKEL DIVERTIKEL

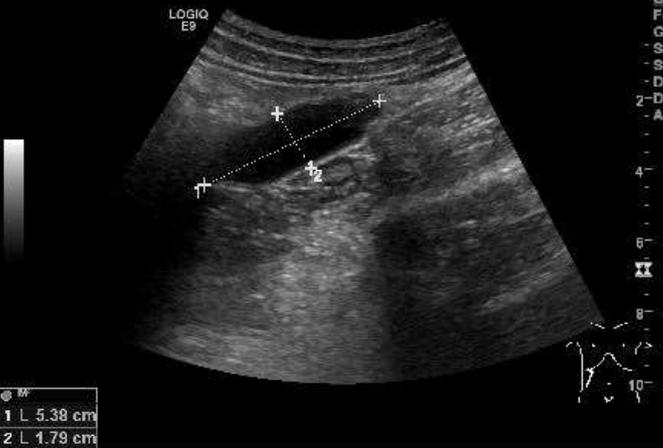
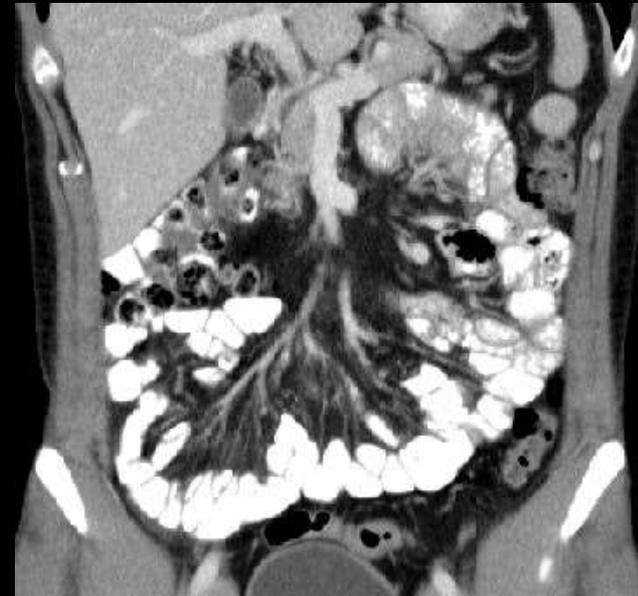


11. ZÖKUMKARZINOM

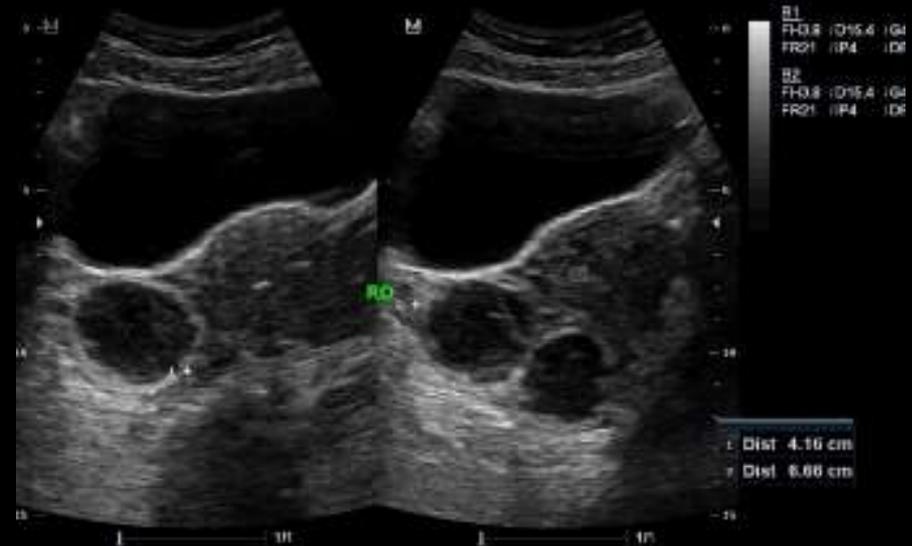


12.MUKOZELE

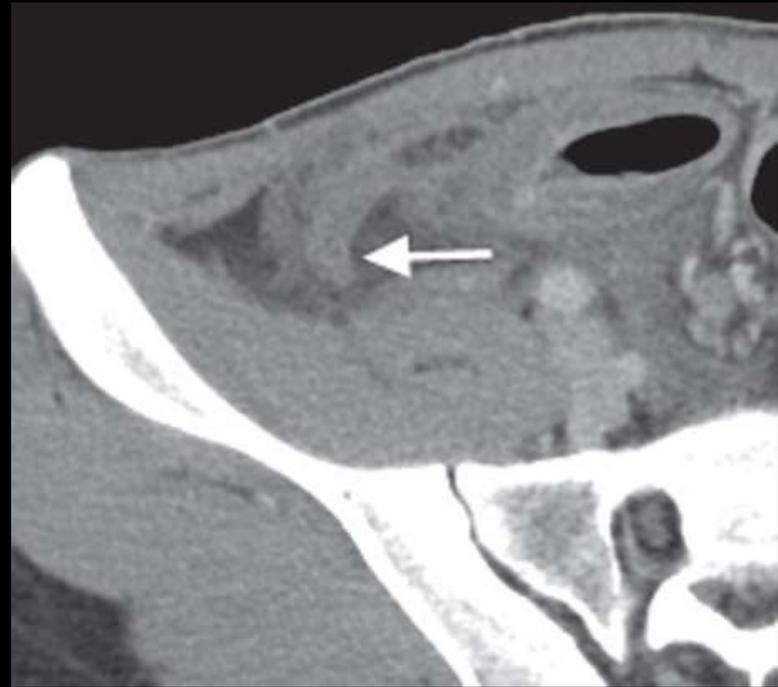
- LAMN, pT4a NX



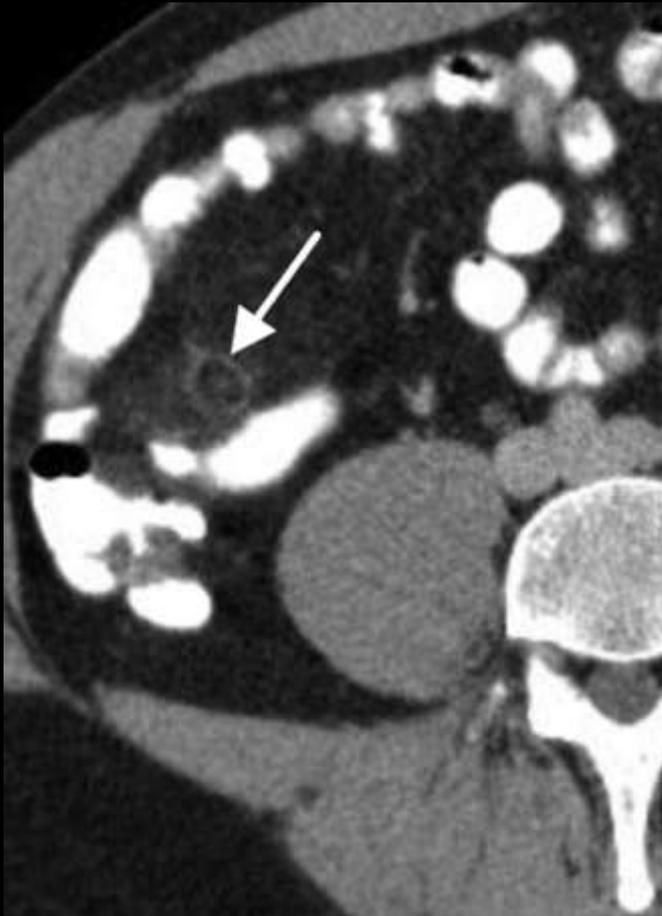
13. PID / HÄMORRH. OVARIALZYZSTE



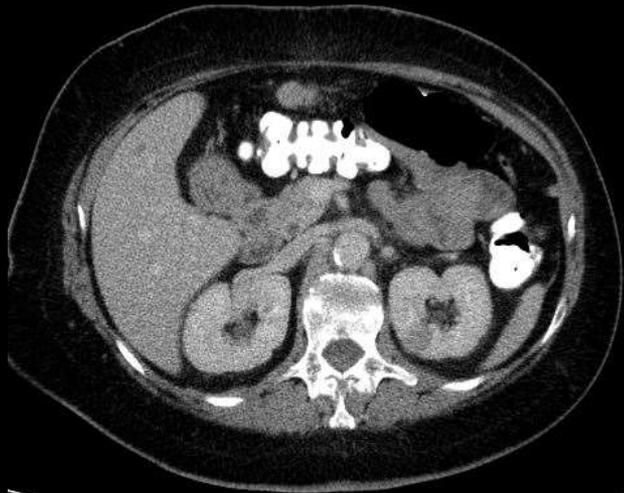
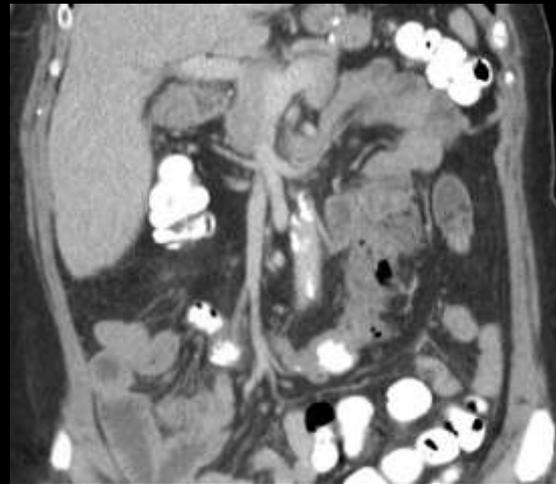
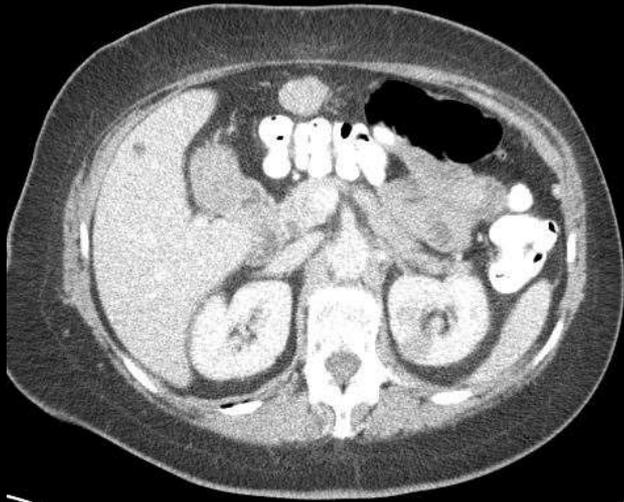
14. MB.CROHN



15. APPENDAGITIS EPIPLOICA

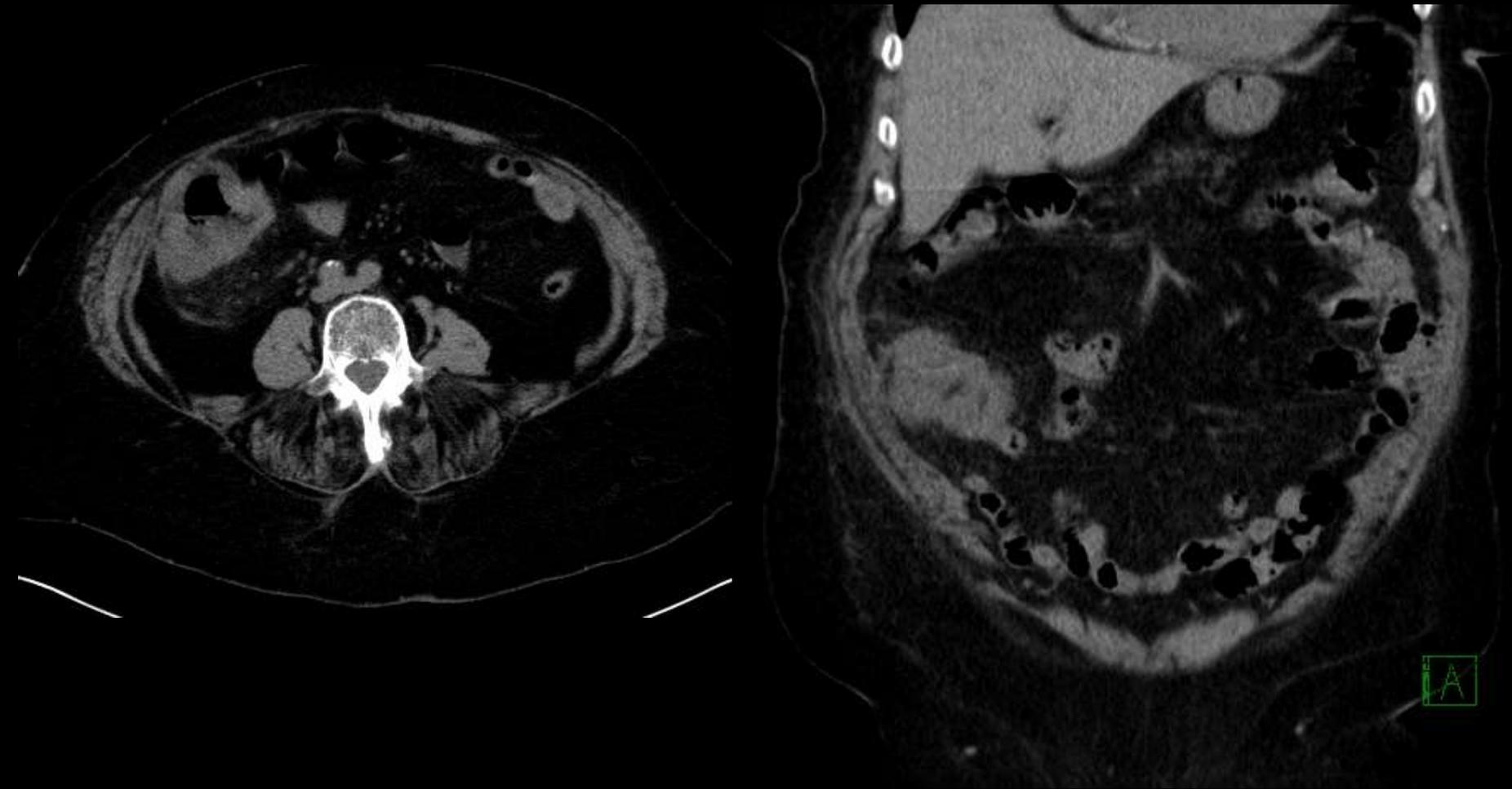


16. APPENDIX IM LI OBERBAUCH

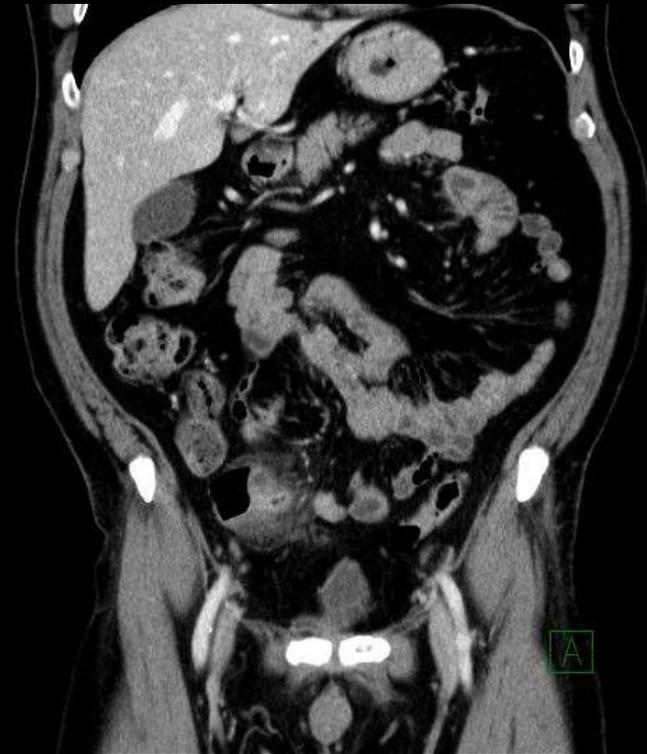




17. TYPHLYTIS

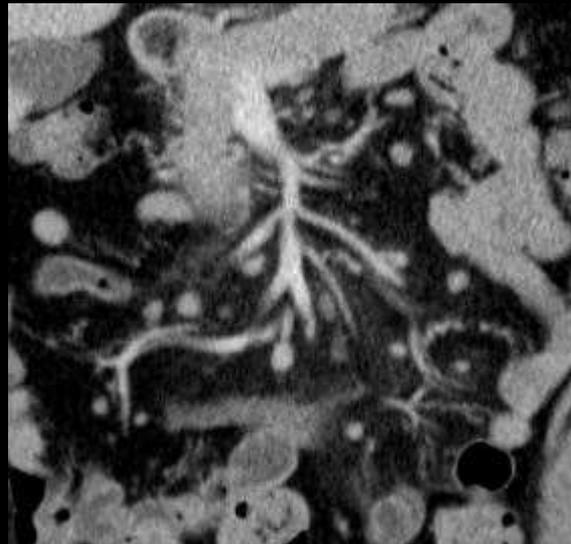
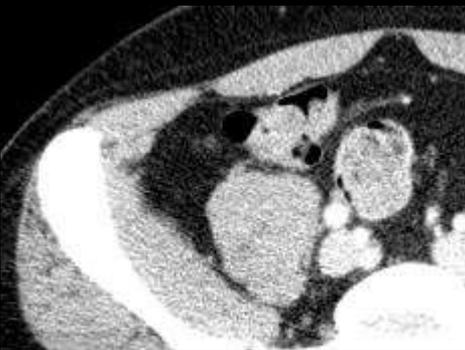
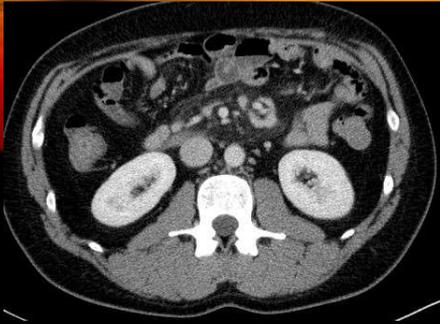


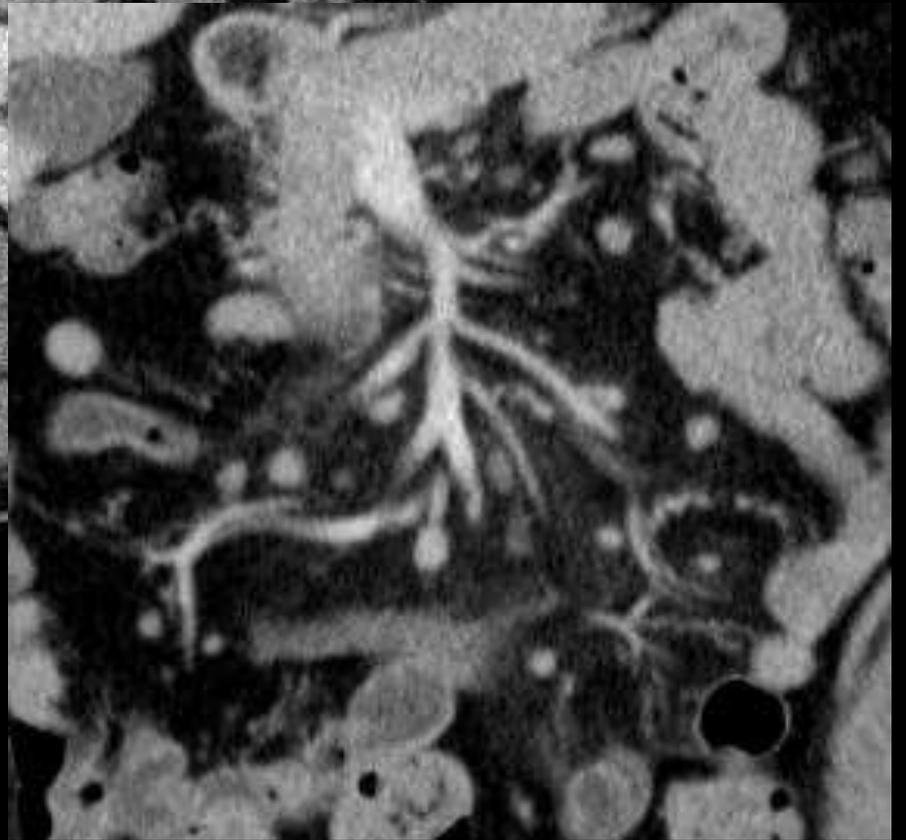
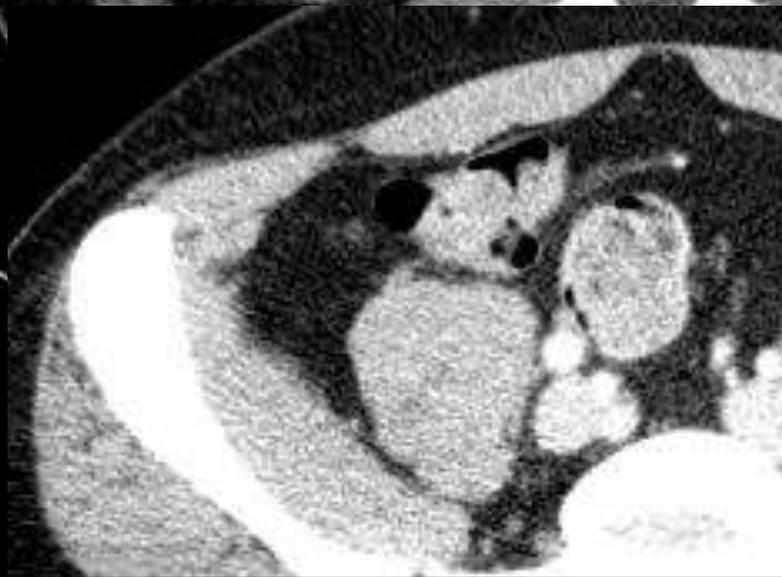
18. SIGMADIVERTIKULITIS





19. LYMPHADENITIS MESENTERIALIS





Ultraschall versus CT

Modalität	Vorteile	Nachteile
US	<ul style="list-style-type: none">- kostengünstig und effektiv, wenn von einem Experten durchgeführt- Reproduzierbarkeit- keine Patientenvorbereitung- non-invasiv- schnell durchführbar- keine Belastung für den Patienten	<ul style="list-style-type: none">- stark untersucherabhängig- eingeschränkte Beurteilbarkeit bei Darmgasüberlagerung, Adipositas und Schwangerschaft- begrenzte Sensitivität/ Spezifität
CT	<ul style="list-style-type: none">- hohe Sensitivität/ Spezifität- kurze Untersuchungszeiten- Nebenbefunde und DD- optimale Therapieplanung- gute Abbildung der Anatomie- hohe Verfügbarkeit	<ul style="list-style-type: none">- Strahlenexposition- Risiken einer etwaigen KM-Gabe



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Review Article

Imaging in acute appendicitis: What, when, and why?



Col Jyotindu Debnath ^{a,*}, Col R.A. George ^b, Brig R. Ravikumar ^c

^a Professor, Department of Radiodiagnosis, Armed Forces Medical College, Pune 411040, India

^b Senior Adviser (Radiodiagnosis), Command Hospital (Air Force), Bengaluru, India

^c Professor & Head, Department of Radiodiagnosis, Armed Forces Medical College, Pune 411040, India

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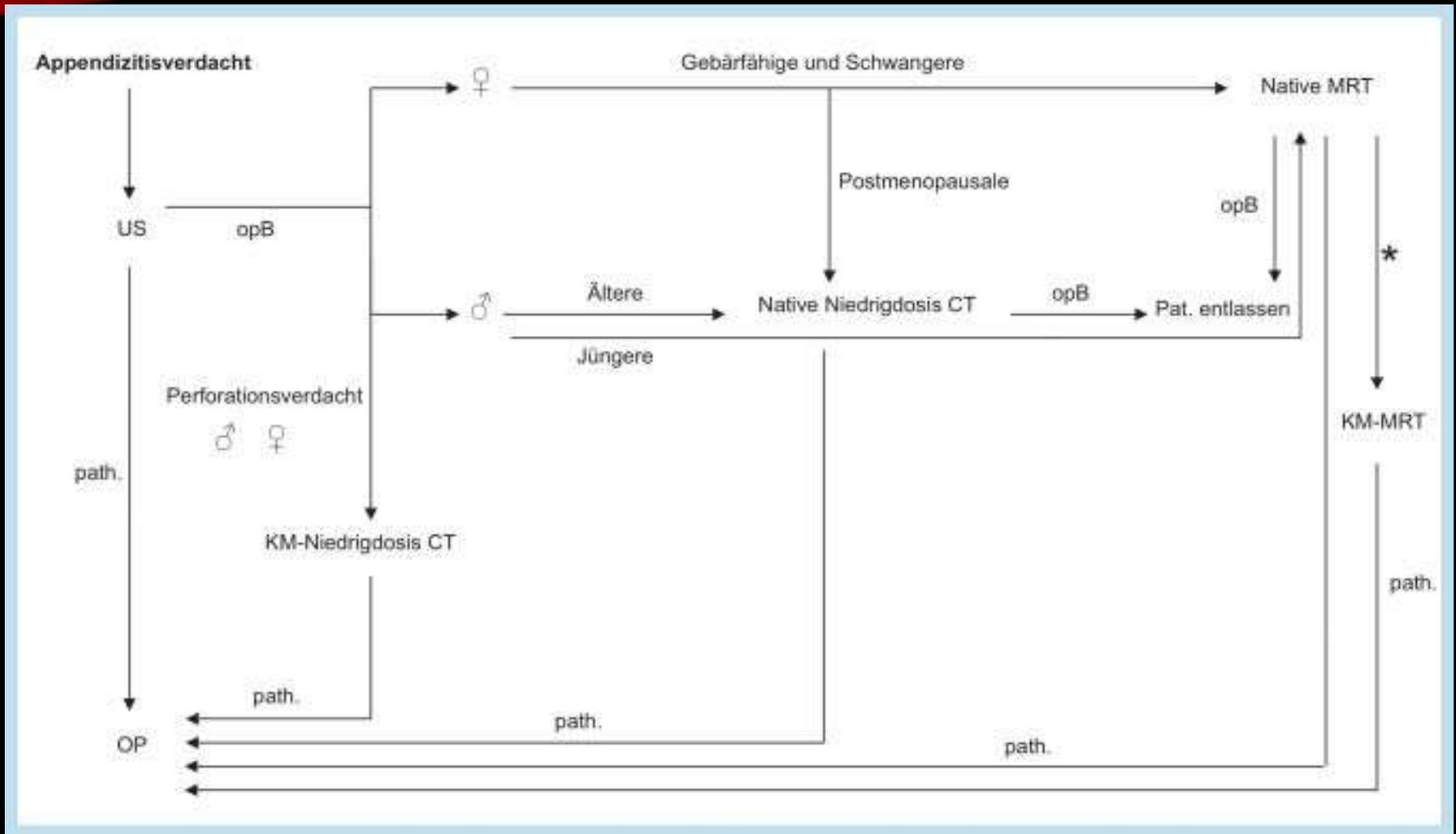
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Available online 29 March 2016

Conclusion

Imaging of AA needs to be streamlined keeping pros and cons of the available investigative modalities. Radiography has practically no role today in the diagnosis and management of AA. USG should be the first line imaging modality for all ages, particularly for children and non-obese young adults including women of reproductive age group. If USG findings are unequivocal and correlate with clinical assessment, no further imaging is needed. In case of equivocal USG findings or clinico-radiological dissociation, follow-up/further imaging (CT scan/MRI) is recommended. In pediatric and pregnant patients with inconclusive initial USG, MRI is the next option. Routine use of CT scan for diagnosis of AA needs to be discouraged.

- konv. Rö ↓
- US first line ↑
- CT second line ↑
- MRT bei Kindern und Schwangeren ↑
- Routine-CT ↓



Bildgebung der Appendizitis beim Erwachsenen (Karul M et al; Fortschr Röntgenstr 2014; 186; 551-558)

Use of Computed Tomography to Determine Perforation in Patients With Acute Appendicitis.

Gaskill CE¹, Simianu WV², Carnell J³, Hippe DS³, Bhargava P³, Flum DR², Davidson GH².

Results

Eighty-nine patients (65% male, average age of 34 years) presenting with right lower quadrant pain underwent CT imaging and prompt appendectomy. Final pathology reported perforation in 48% (n = 43) of cases. Radiologic diagnosis of perforation was reported in 9% (n = 8), correctly identifying perforation in 37.5% (n = 3), and incorrectly reporting perforation in 62.5% of nonperforated cases per pathology. Radiology missed 93% (n = 40) of perforations postoperatively diagnosed by pathology. There was no secondary finding (fat stranding, diameter >13 mm, abscess, cecal wall thickening, periappendiceal gas, simple fluid collection, appendicolith, and phlegmon) with a clinically reliable sensitivity or specificity to predict perforated appendicitis. Surgeon's report of perforation was consistent with the pathology report of perforation in only 28% of cases.

Conclusions

The usefulness of a CT for determining perforation in acute appendicitis is limited, and methods to improve precision in identifying patients with complicated appendicitis should be explored as this may help for improving risk prediction for failure of treatment with antibiotic therapy and help guide patients and providers in shared decision-making for treatment options.

- CT sehr begrenzt bei Detektion einer Perforation ↓

**... wirst sehen, mit
der Aktion komm'
ich sicher zu einem
Chirurgen-Kongress!**



**Da könntest
recht haben,
Leonid.....**

Danke für die Aufmerksamkeit!

REFERENZEN

- Difficulties in the diagnosis of Appendicitis – review of CT and US images (Kosaka N.; Emerg.Radiolog. 2007)
- Pitfalls in CT diagnosis of Appendicitis: Pictorial essay (Shademan A; Tappouni RFR.; JMIRO 57, 2013)
- Eur Radiol. 2013; 23; 1882 – 1890
- Diagnostic Imaging
- SONO-Atlas
- Bildgebung der Appendizitis beim Erwachsenen (Karul M et al; Fortschr Röntgenstr 2014; 186; 551-558)