CONTRAST-ENHANCED ULTRASOUND IN DETECTION AND FOLLOW-UP OF FOCAL RENAL INFECTIONS IN CHILDREN

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INTRODUCTION

- focal renal infections, **focal nephritis** and **renal abscesses**, are not very common in children
- clinical presentation usually nonspecific and varying →

  importance of imaging in early diagnosis and treatment
- haematogenous spread or ascending urinary tract infection
- most frequently isolated pathogens in focal renal infections:

  Escherichia coli and *Staphylococcus aureus*

INTRODUCTION

- ULTRASOUND: 1st line imaging method for focal renal infections
- CT or MRI for final diagnosis - not optimal for the use in children
- CONTRAST ENHANCED ULTRASOUND (CEUS)

PURPOSE

- investigation of the efficacy and clinical utility of i.v. renal CEUS as an alternative imaging method for a diagnosis and follow-up of focal renal infections in children
- description of various enhancement patterns of focal renal infection
- suggestion of follow-up algorithm to objectively monitor renal abscesses and possible chronic renal parenchymal changes

MATERIAL AND METHODS

- retrospective study – all data obtained from medical and imaging records
- inclusion criteria: children in whom focal renal infection was suspected at the University Children's hospital Ljubljana from January 2018 to February 2022

MATERIAL AND METHODS

- **Clinical, laboratory and treatment data**

- clinical signs and symptoms
- CRP, ESR, PCT, WBC count, haemoglobin, potassium and sodium levels, creatinine, blood urea nitrogen and microbiology data (urine and blood cultures)
- choice of antibiotics, mode of administration and duration of treatment

MATERIAL AND METHODS

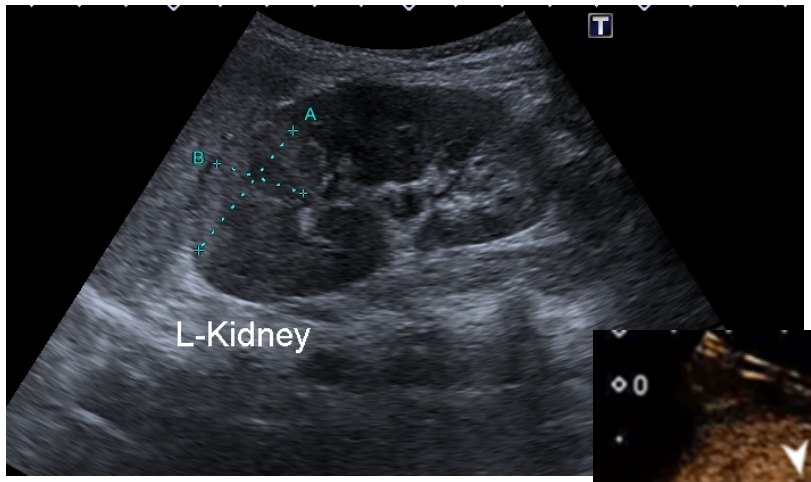
- **Kidney US and iv CEUS of the kidney**
  - Aplio 500 US machine for conventional, colour Doppler US and CEUS using1.9-5.0 MHz convex or 7.5-12 MHz linear transducer
  - second-generation ultrasound contrast agent SonoVue®
  - dose: 0.03ml/kg for convex probe or 0.05ml/kg for linear probe
  - supine or prone position

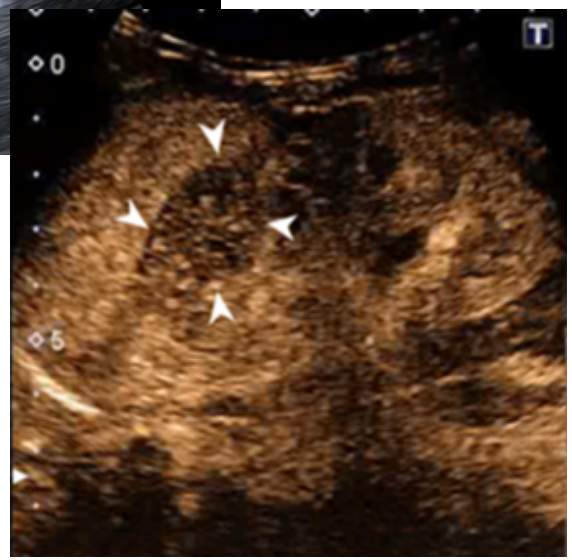
MATERIAL AND METHODS

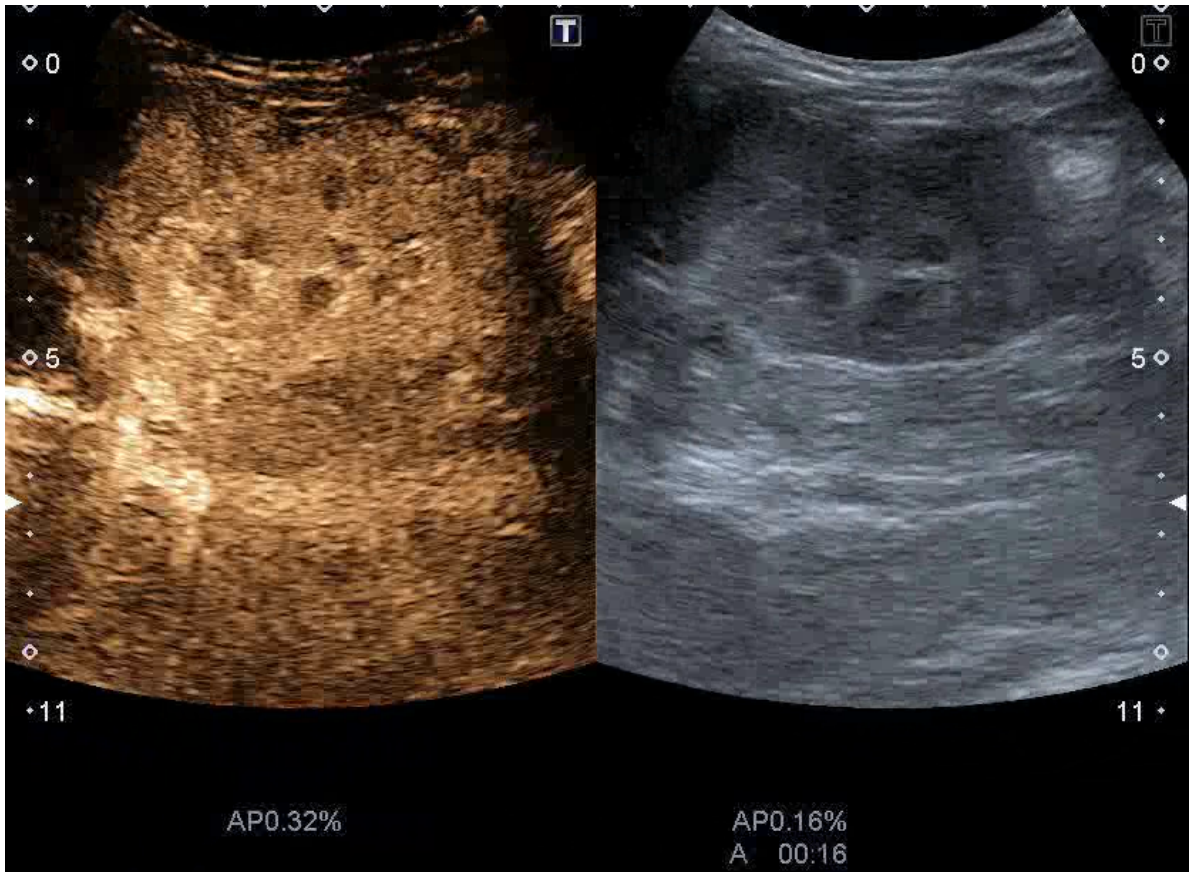
- **CEUS enhancement patterns of focal renal infections**

FOCAL NEPHRITIS	hypoenhanced area with slow wash out
EARLY STAGE OF ABSCESS	hypoenhanced area with nonenhanced part
MATURE ABSCESS	nonenhanced central part with hyperenhanced capsule
SUBCAPSULAR ABSCESS	boundary between the avascular nonenhancing subcapsular collection and the enhancing renal parenchyma
PERINEPHRITIC CHANGES	perinephritic fluid (nonenhanced part) and hyperenhanced inflammatory changed perinephritic fat

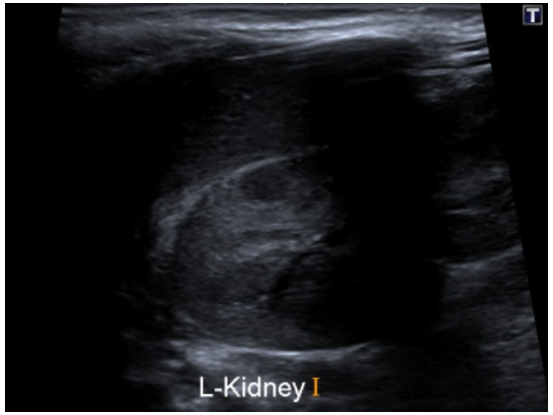
FOCAL NEPHRITIS

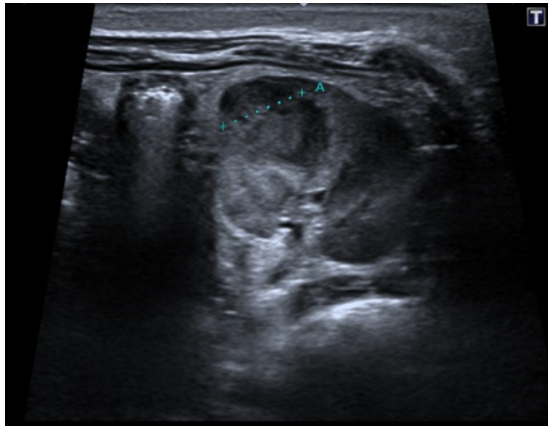


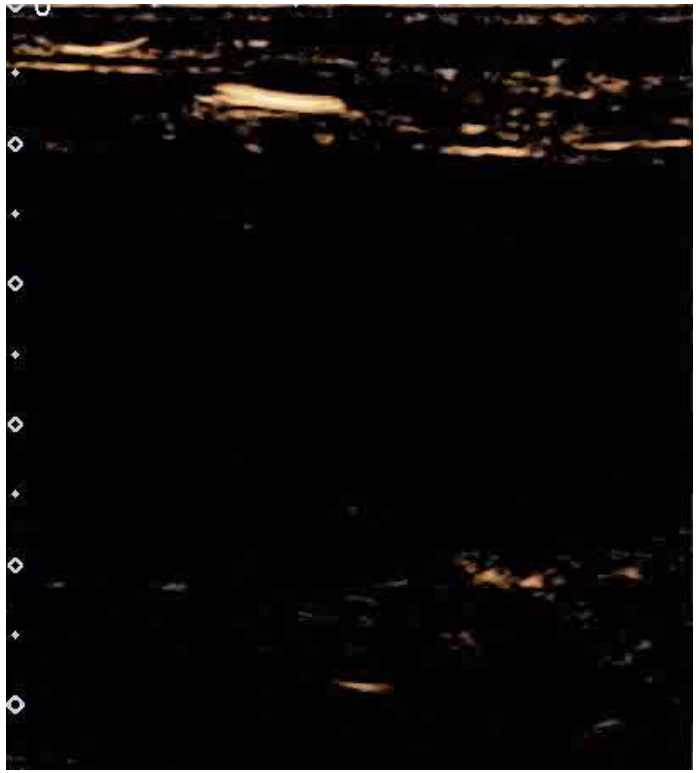


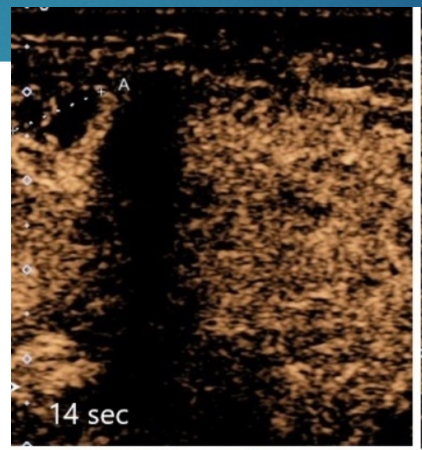


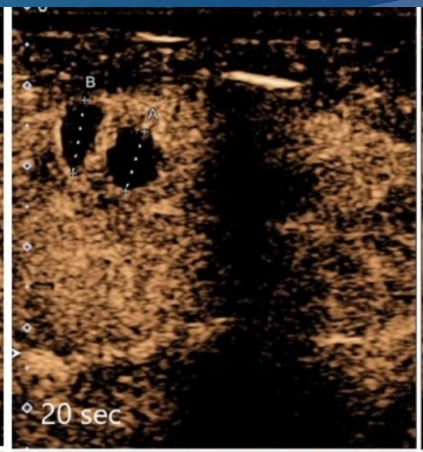
KIDNEY PARENCHYMAL ABSCESSES

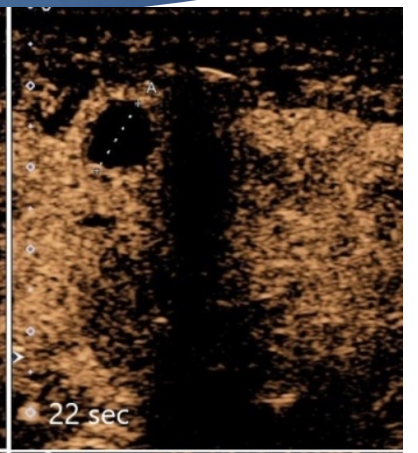


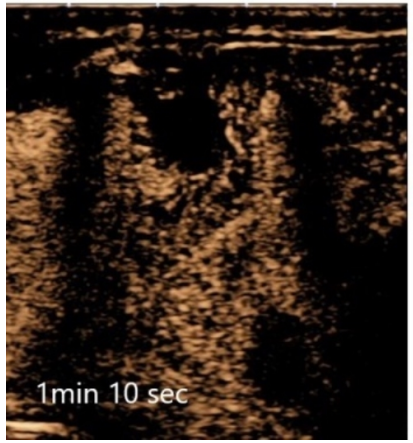


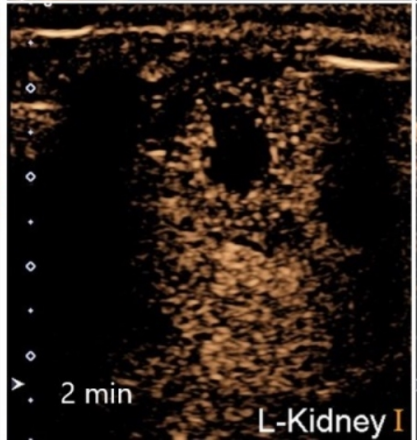


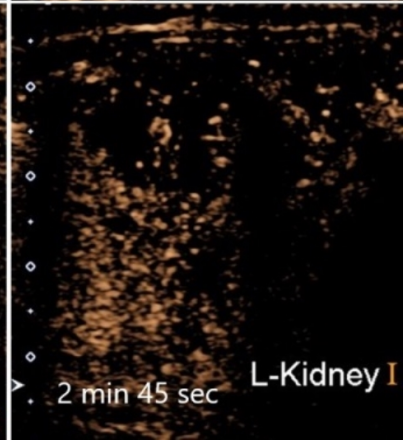




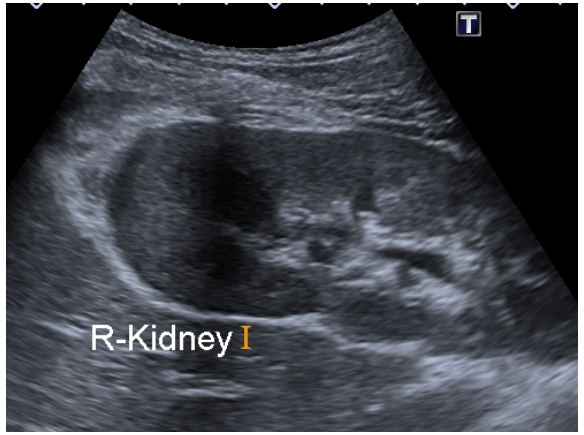


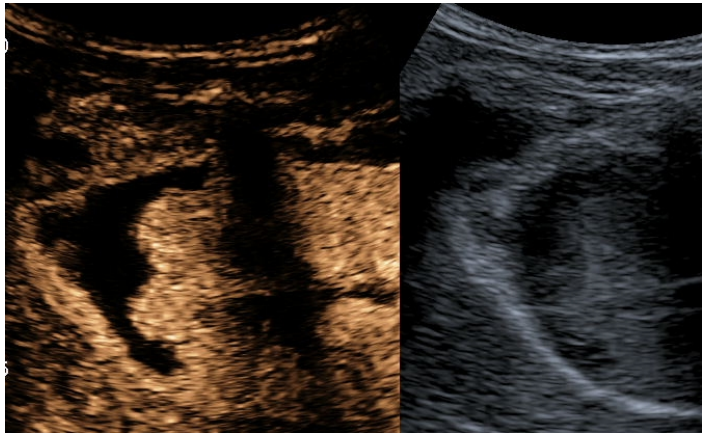


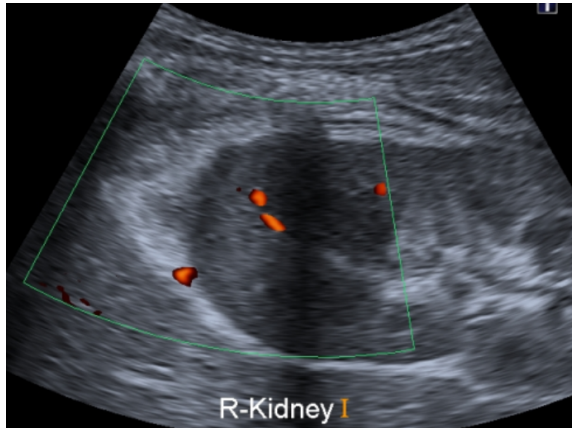


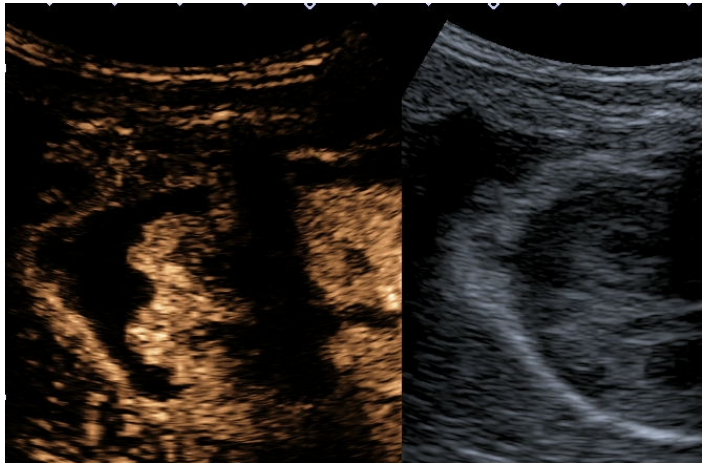


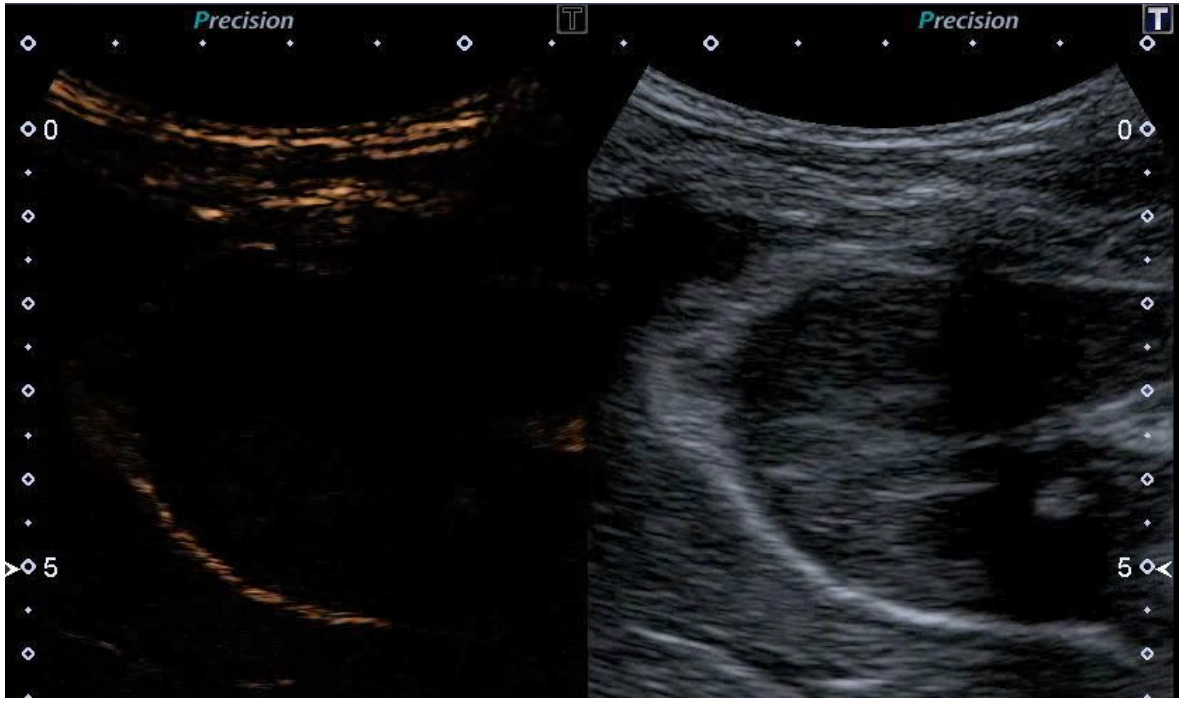
SUBCAPSULAR RENAL ABSCESS



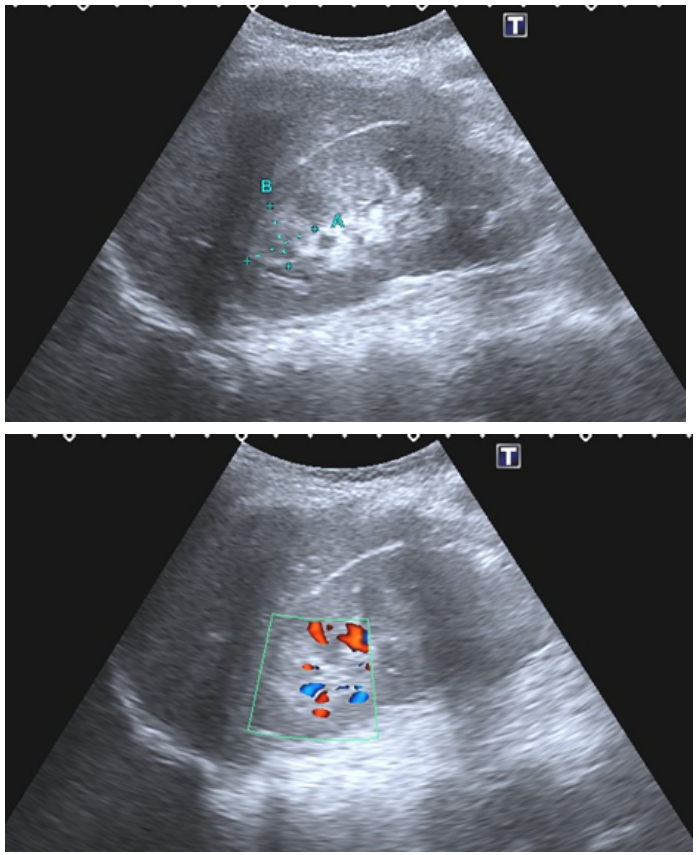








KIDNEY PSEUDOLESION



RESULTS

- 14 children (6 m to 17 y),
- 11 girls and 3 boys
- all patients presented similar clinical symptoms and elevated inflammatory markers
- 3 children risk factors for bacteraemia, 3 had VUR
- 9 had positive urine culture (7 E. coli, 2 Enterococcus faecalis)
- blood cultures all negative

	Focal nephritis	**Renal abscess (parenchymal and subcapsular)**	**Pseudolesion**
Number of children	3	7	4
Age (years)	4-9 (avg. 6)	0.5-12 (avg. 5.5)	0.5-17 (avg. 8.6)
Gender	3 girls	2 boys, 5 girls	1 boy, 3 girls
Symptoms	Fever, chills, pain in the abdomen and flank pain, smelly urine, vomiting, diarrhoea, headache	Fever, chills, pain in the abdomen and flank pain, smelly urine, vomiting, diarrhoea, headache, changes in mental status, photophobia	Fever, chills, pain in the abdomen and flank pain, smelly urine, vomiting, diarrhoea, headache
Laboratory at admission			
CRP (mg/L)	13-228 (avg. 97)	39-478 (avg. 245)	31-144 (avg. 89)
WBC ($x10^9$/L)	6.3-19.9 (avg. 12.3)	13-32.7 (avg. 20.7)	6.2-28.6 (avg. 17.6)
First urinalysis	Few to numerous bacteria, protein, nitrites, WBCs	Few to numerous bacteria, protein, WBCs	Few to numerous bacteria, protein, nitrites, WBCs
Urine culture	2x E.coli	2x E. coli, 2x E. faecalis	3x E.coli
Blood culture	All sterile	All sterile	All sterile

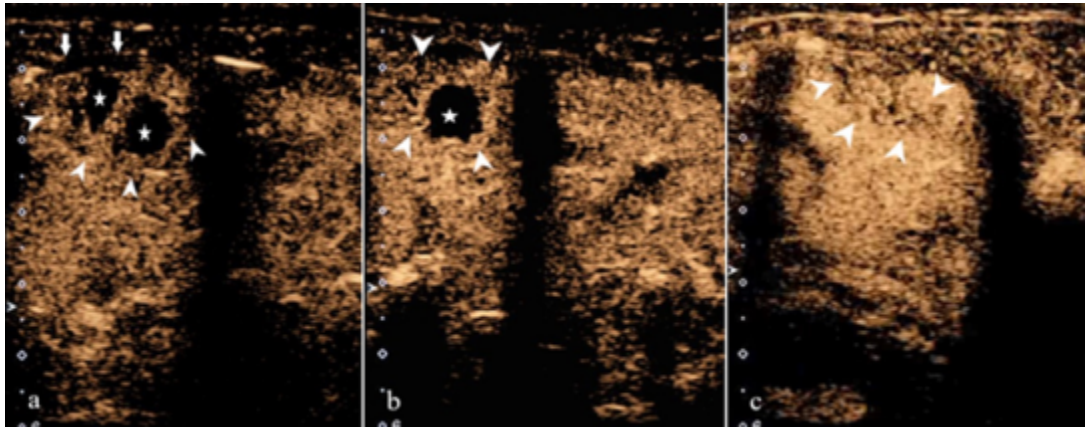
RESULTS

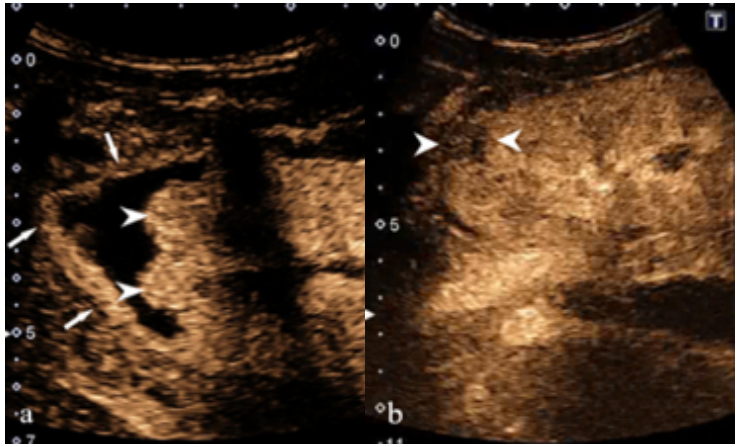
- 10 focal infection (3 focal nephritis, 7 renal abscess)
- 4 pseudolesions
- initial treatment with broad-spectrum iv atb and then oral atb
- treatment duration: 3-9 w, depending on the type of focal infectious lesion
- follow-up: no chr. changes
- no need for percutaneous drainage or surgical treatment

	Focal nephritis	Renal abscess (parenchymal and subcapsular)	Pseudolesion
CEUS findings			
Description	Hypoenhanced focal area(s) with slow wash out comparable to normal renal parenchyma	3x subcapsular (nonenhanced subcapsular areal with hyperenhanced capsula and perirenal tissue changes), 3x parenchymal (nonenhanced areals in renal parenchyma with or without hyperenhanced capsula), 1x combination	Similar enhancement pattern of focal lesion as normal kidney parenchyma
Perirenal fat inflammation	1x yes, 2x no	5x yes, 2x no	no
Treatment			
Intravenous antibiotic (duration: weeks)	all 1	1.5-7 (avg. 3.4)	0.5-1 (avg. 0.8)
Oral antibiotic treatment (duration: weeks)	2-3 (avg. 2.3)	2-7 (avg. 3.7)	0-1 (avg. 0.8)
Total duration of antibiotic (weeks)	3-4 (avg. 3.3)	6-9 (avg. 7.3)	0.5-2 (avg. 1.4)

RESULTS

- Follow-up CEUS in 7 renal abscesses
  - 7-10 days
  - 3-4 weeks
  - 6-8 weeks
  - 3-6 months (chr. parenchymal remnants)





LIMITATIONS OF RENAL CEUS

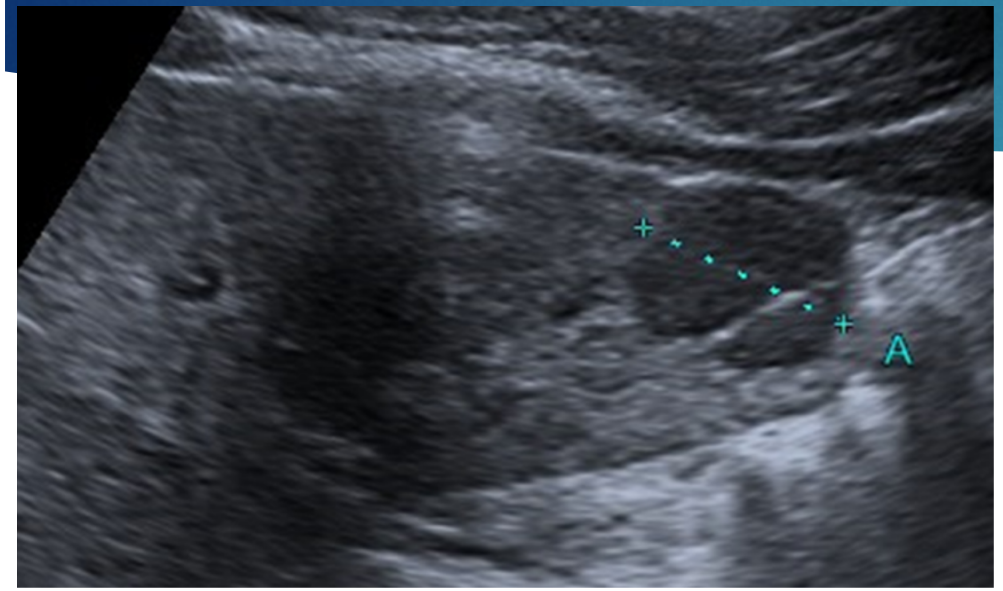
- kidney focal lesion is not well depicted (bowel gas interposition, poor child co-operation, obese children…)
- contraindications: hypersensitivity to the PEG of UCA, severe pulmonary and uncontrolled systemic hypertension
- off-label use of iv second-generation UCA in children

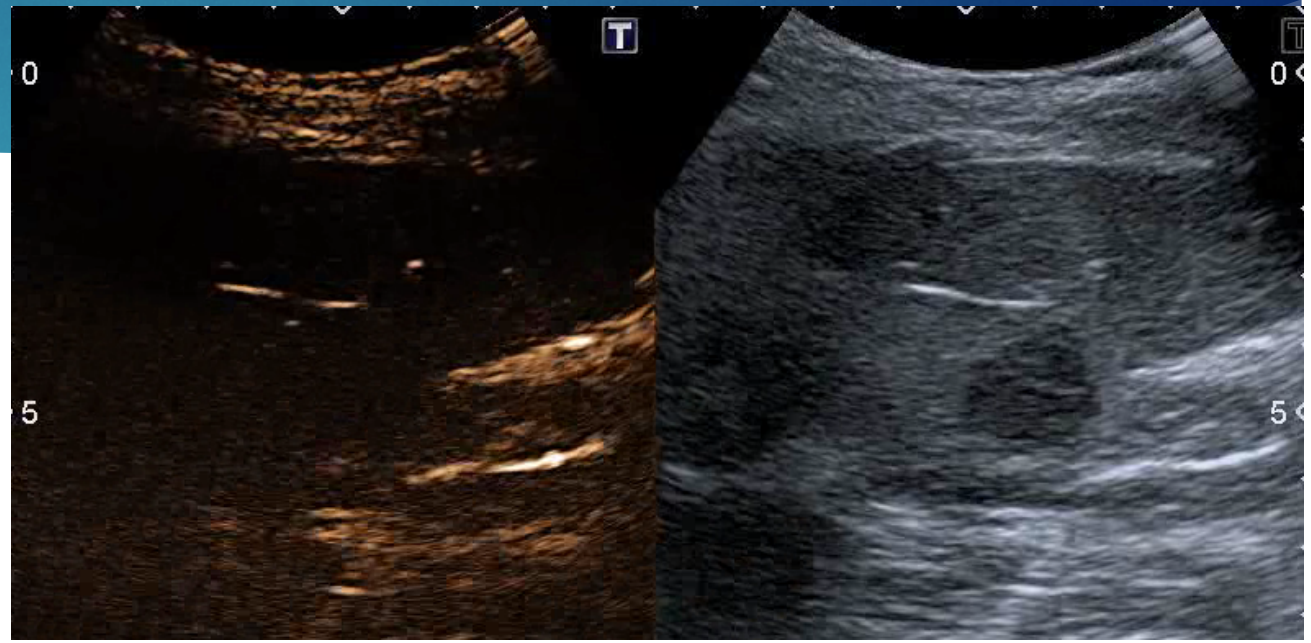
CONCLUSION

CEUS was found to be an efficient, self-sufficient, safe, children-friendly imaging method for timely diagnosis of focal renal infections, their objective follow-up during antibiotic treatment, and objective evaluation of potential chronical changes of renal parenchyma.

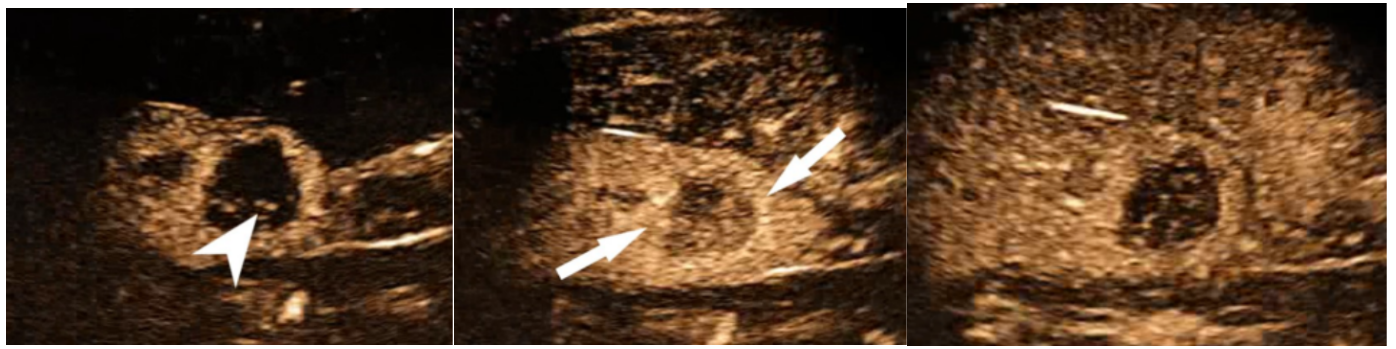
DIFFERENTIAL DIAGNOSIS

- PARENCHYMAL PSEUDOLESION (same enhancement as the surroudifferentainding renal parenchyma)
- RENAL CELL CARCINOMA (hypoenhanced, but fast wash out))
- WILMS TUMOR (non-homogenous hyperenhancement, multiple nonenhanced areas of necrosis)





13 year-old girl.
US to characterize a focal kidney lesion – complex cyst? solid lesion?



Wash-out →malignant pattern of enhancement

PAPILLARY RENAL CELL CARCINOMA TYPE 1