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

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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 using 1.9-5.0 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**

<table>
<thead>
<tr>
<th>Condition</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>FOCAL NEPHRITIS</td>
<td>Hypoenhanced area with slow wash out</td>
</tr>
<tr>
<td>EARLY STAGE OF ABSCESS</td>
<td>Hypoenhanced area with nonenhanced part</td>
</tr>
<tr>
<td>MATURE ABSCESS</td>
<td>Nonenhanced central part with hyperenhanced capsule</td>
</tr>
<tr>
<td>SUBCAPSULAR ABSCESS</td>
<td>Boundary between the avascular nonenhancing subcapsular collection and the enhancing renal parenchyma</td>
</tr>
<tr>
<td>PERINEPHRITIC CHANGES</td>
<td>Perinephritic fluid (nonenhanced part) and hyperenhanced inflammatory changed perinephritic fat</td>
</tr>
</tbody>
</table>
FOCAL NEPHRITIS
KIDNEY PARENCHYMAL ABSCESSSES
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

<table>
<thead>
<tr>
<th></th>
<th>Focal nephritis</th>
<th>Renal abscess (parenchymal and subcapsular)</th>
<th>Pseudolesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of children</td>
<td>3</td>
<td>7</td>
<td>4</td>
</tr>
<tr>
<td>Age (years)</td>
<td>4.9 (avg. 6)</td>
<td>0.5-12 (avg. 5.5)</td>
<td>0.5-17 (avg. 8.6)</td>
</tr>
<tr>
<td>Gender</td>
<td>3 girls</td>
<td>2 boys, 5 girls</td>
<td>1 boy, 3 girls</td>
</tr>
<tr>
<td>Symptoms</td>
<td>Fever, chills, pain in the abdomen and flank pain, smelly urine, vomiting, diarrhoea, headache</td>
<td>Fever, chills, pain in the abdomen and flank pain, smelly urine, vomiting, diarrhoea, headache, changes in mental status, photophobia</td>
<td></td>
</tr>
<tr>
<td>Laboratory at admission</td>
<td>CRP (mg/L) 13-228 (avg. 97)</td>
<td>39-478 (avg. 245)</td>
<td>31-144 (avg. 89)</td>
</tr>
<tr>
<td></td>
<td>WBC (x10^9/L) 6.3-19.9 (avg. 12.3)</td>
<td>13-32.7 (avg. 20.7)</td>
<td>6.2-28.6 (avg. 17.6)</td>
</tr>
<tr>
<td></td>
<td>First urinalysis Few to numerous bacteria, protein, nitrites, WBCs</td>
<td>Few to numerous bacteria, protein, WBCs</td>
<td>Few to numerous bacteria, protein, nitrites, WBCs</td>
</tr>
<tr>
<td></td>
<td>Urine culture 2x E.coli</td>
<td>2x E. coli, 2x E. faecalis</td>
<td>3x E. coli</td>
</tr>
<tr>
<td></td>
<td>Blood culture All sterile</td>
<td>All sterile</td>
<td>All sterile</td>
</tr>
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</table>
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

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<tr>
<td>Hypoenhanced focal area(s) with slow wash out comparable to normal renal parenchyma</td>
<td>3x subcapsular (nonenhanced subcapsular area with hyperenhanced capsule and perirenal tissue changes), 3x parenchymal (nonenhanced areals in renal parenchyma with or without hyperenhanced capsule), 1x combination</td>
<td>Similar enhancement pattern of focal lesion as normal kidney parenchyma</td>
<td></td>
</tr>
<tr>
<td>Perirenal fat inflammation</td>
<td>1x yes, 2x no</td>
<td>5x yes, 2x no</td>
<td>no</td>
</tr>
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<th>Treatment</th>
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<th>Pseudolesion</th>
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<tbody>
<tr>
<td>Intravenous antibiotic (duration: weeks)</td>
<td>all 1</td>
<td>1.5-7 (avg. 3.4)</td>
<td>0.5-1 (avg. 0.8)</td>
</tr>
<tr>
<td>Oral antibiotic treatment (duration: weeks)</td>
<td>2-3 (avg. 2.3)</td>
<td>2-7 (avg. 3.7)</td>
<td>0-1 (avg. 0.8)</td>
</tr>
<tr>
<td>Total duration of antibiotic (weeks)</td>
<td>3-4 (avg. 3.3)</td>
<td>6-9 (avg. 7.3)</td>
<td>0.5-2 (avg. 1.4)</td>
</tr>
</tbody>
</table>
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 PSEUDELESION (same enhancement as the surrounding 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