University Clinical Centre Ljubljana,
Children's hospital Ljubljana,
Radiology Unit

Comparison between Renal Scintigraphy and Functional MR Urography

Usporedba dinamičke scintigrafije bubrega naspram Funkcionalne MR urografije - naša iskustva

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INTRODUCTION

- US - ultrasound of urinary tract: first imaging method
- Renal scintigraphy is known to be a gold standard for renal function evaluation
- MRU - magnetic resonance urography: next step in evaluation in pediatric uroradiology
- fMRU (functional MRU) could acquire both morphological and functional data of genitourinary system in one study

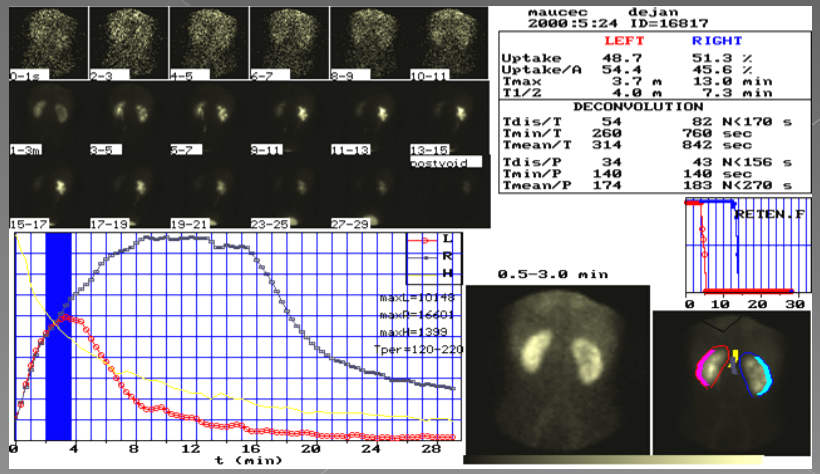
INTRODUCTION

- 1986 - MRI was introduced in pediatric urology
- 1987 - non contrast MRI sequence (static fluid MRU) - first method to visualize the urinary tract
- 1999 - MRU in pediatric urogenital imaging
- 2000 – fMRU in an animal model
- 2002 – fMRU in children with congenital urinary tract dilatation

Cerwinka; MRU in pediatric urology. J Ped Urol 2008;4:74-83.

Renal Scintigraphy

- Preparation: good hydration
- Catheterization of the urinary bladder – if needed
- Injection of a radiotracer – 99mTc MAG3 ~ 100 MBq
- Acquisition :
- 1 – 2 sec scintigraph – duration up to 1 min,
- 10 - 30 sec scintigraph – duration up to 30 minut. If detect kidney blockages, diuretic is applied within 15 min
- postvoiding imaging – takes few min. Acquisition is the same as at beginning
- Effective dose: 0,012mSv/MBq.

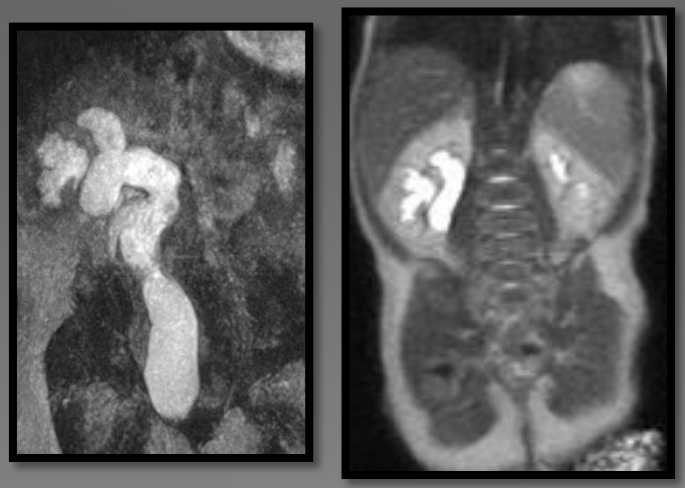


MR UROGRAPHY

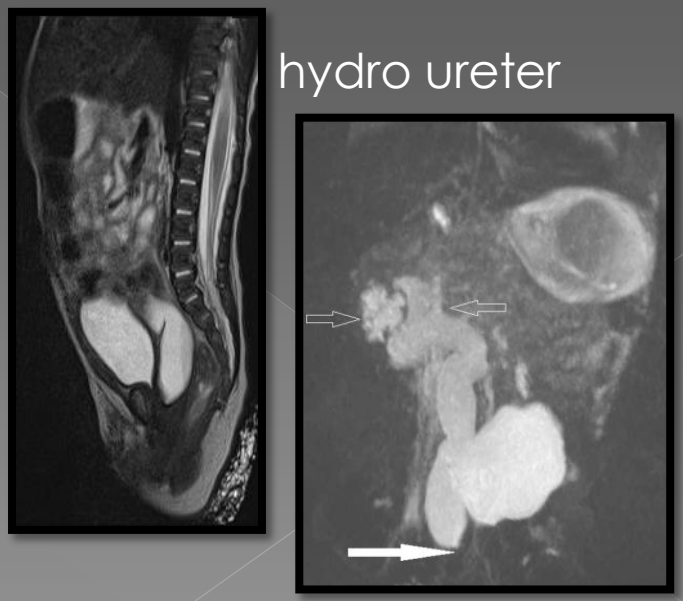
- ANATOMIC-MORPHOLOGICAL GROUP
  - static-fluid MRU
  - excretory MRU
  - conventional (semi-functional) MRU
- FUNCTIONAL GROUP – functional MRU (fMRU)

STATIC-FLUID MRU

- SYNONIMS: static MRU, T2-W MRU, MR hydrourography
- TECHNIQUE: water weighted sequences without application of CM
- INDICATION: visualization of large fluid-filled structures such as megaureters, large ureteroceles, hydronephrosis, dilated ectopic ureter and cystic renal disease.



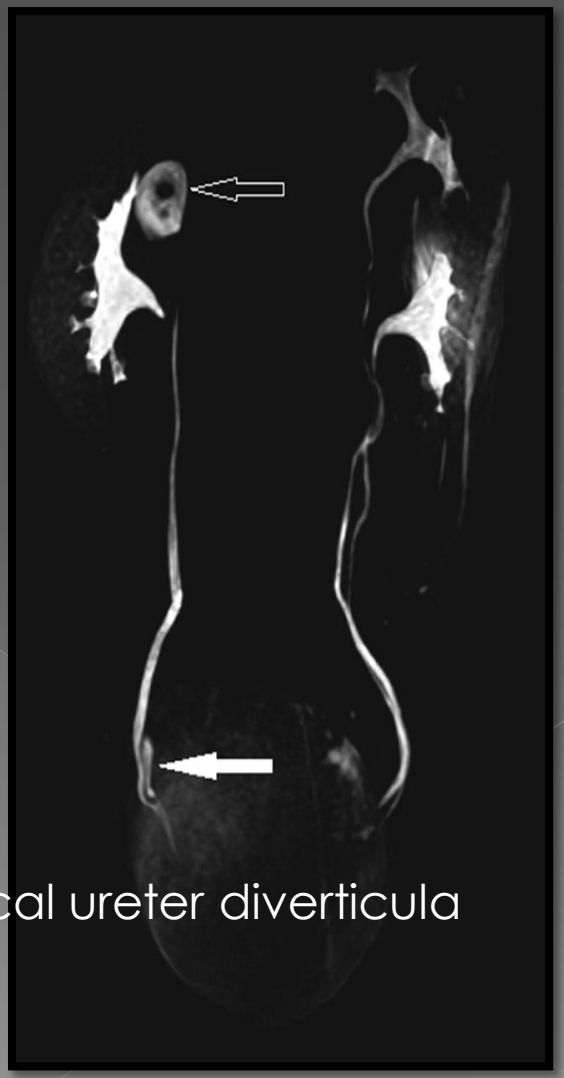
duplication of collecting system with hydronephrosis of upper pole and ectopic megaureter



hydro ureter

EXCRETORY MRU

- SYNONYM: T1-weighted MRU
- TECHNIQUES:
  - roughly analogous to CT urography and conventional i.v. urography,
  - i.v. administered of paramagnetic CM
- INDICATION: visualization of small and subtile anomalies in the non-dilated urinary tract.



CONVENTIONAL MRU

= frequently used in most centres =

- SYNONYMS: classic, semi-quantitative
- TECHNIQUES: conventional MR imaging sequences beside static-fluid and excretory MRU
- INDICATION:
  - visualization of kidney parenchyma and collecting system, good for aorta and renal vessels
  - subjective kidney function evaluation (renal parenchyma enhancement, excretion of contrast medium)

FUNCTIONAL MRU - fMRU

- TECHNIQUES: no standardization, no consensus about
  - patient preparation:
    - hydration (i.v., per os)
    - catheterization of the urinary bladder – when is recommended?
  - Time of application of diuretic
  - Time and dose of i.v. paramagnetic CM
  - MR sequences:
    - for morphology,
    - for fluid sequences,
    - for dynamic renography.
- INDICATION: when we need quantitative assessment of kidney function and urinary drainage besides anatomical and morphological information – „all in one method“, „Holy Grail“

INDICATIONS FOR fMRU

- congenital anomalies of kidney and urinary tract
- hydronephrosis and suspected obstruction of the urinary tract
- renal dysplasia, chronic pyelonephritis, renal scarring
- renal masses
- pre and postoperative evaluation
- transplanted kidney evaluation

LIMITATIONS OF fMRU

- deep sedation/general anesthesia in younger children
- semi-invasive method – still need bladder catheterization in certain cases and injection of CM
- time consuming method
- high cost
- low sensitivity in detecting calcifications
- be aware of limitations in interpretation of functional results

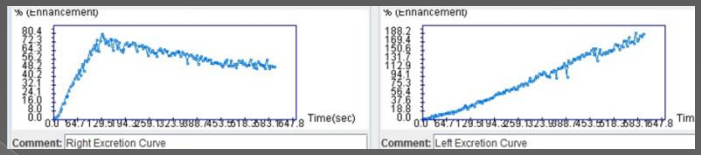
FUNCTIONAL MRU - fMRU

MORPHOLOGIC/ANATOMIC

- size, position and morphology of the kidneys,
- presence or absence of cortical or medullary scars,
- demonstrate vascular flow and ishemic region,
- degree of hydronephrosis
- identification of transition in ureteric caliber,
- the ureter throughout its length, including insertion into the bladder,
- anomalies of the bladder,
- number and position of renal arteries

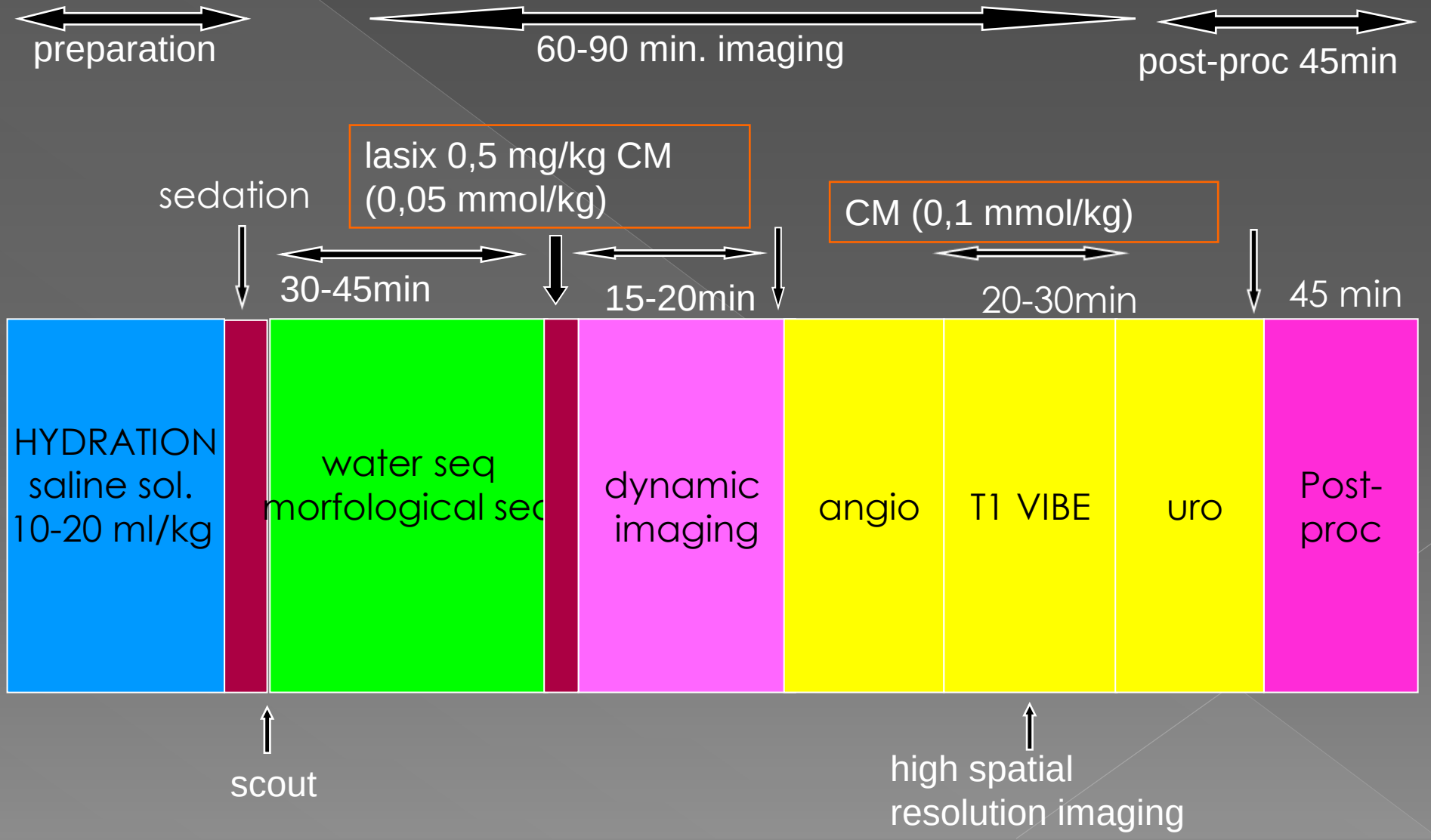
FUNCTIONAL

- excretion curve
- split renal function
- time intervals
- kidney volume



Right Kidney	Left Kidney
Volume (ml): 25 (%): 45	Volume (ml): 30 (%): 55
Renogram Area (%): 53 Renogram Area + Volume (%): 48	Renogram Area (%): 47 Renogram Area + Volume (%): 52
Patlak (%): 56.0 Patlak + Volume (%): 52.0	Patlak (%): 44.0 Patlak + Volume (%): 48.0

fMRU – HOW WE DO IT?



Parameters of standard MRU protocol in an 18-month-old child with a 1,5 T imager (Aera, Siemens, Ljubljana, Slovenia)							
Assessment	Renal parenchyma	Excretory system	Excretory system	Excretory system	Bladder / ureterocele	Renography	Parenchyma and cavitas after injection
Weighting	T2	Heavily T2 Thick slab	T2	T2	T2	T1	T1
Siemens name	HASTE	HASTE	SPACE	TSE	HASTE	Turbo FLASH	VIBE
Orientation	Coronal	Coronal	Coronal	Coronal	Sagital	Coronal	Coronal
TR (ms)	1100	4500	2500	2000	1100	590	4,29
TE (ms)	100	750	600	100	100	1,26	1,57
FA (°)	167	180	130	160	167	5	10
TI (ms)	-	-	-	-	-	250	-
Fat-saturation	Yes	Yes	Yes	Yes	Yes	No	Yes
Slice thickness (mm)	4	50	1	3	4	7	1,3
Space between slices	0%	50%	-	10%	0%	10%	20%
FOV (mm)	200	300	380	200	220	300	200
Acquisition matrix	200x320	179x256	353x384	270x512	200x320	190x256	113x224
Acquisition time	3,15 min	9 sec	6,10 min	4,1 min	1,39 min	10 min (150 meritev)	2,22 min

Sirnik A (2014)

PROGRAMS FOR FUNCTIONAL EVALUATION

- ImageJ MRU processing software

Vivier PH et al Pediatr Radiol (2010) 40:739–746.

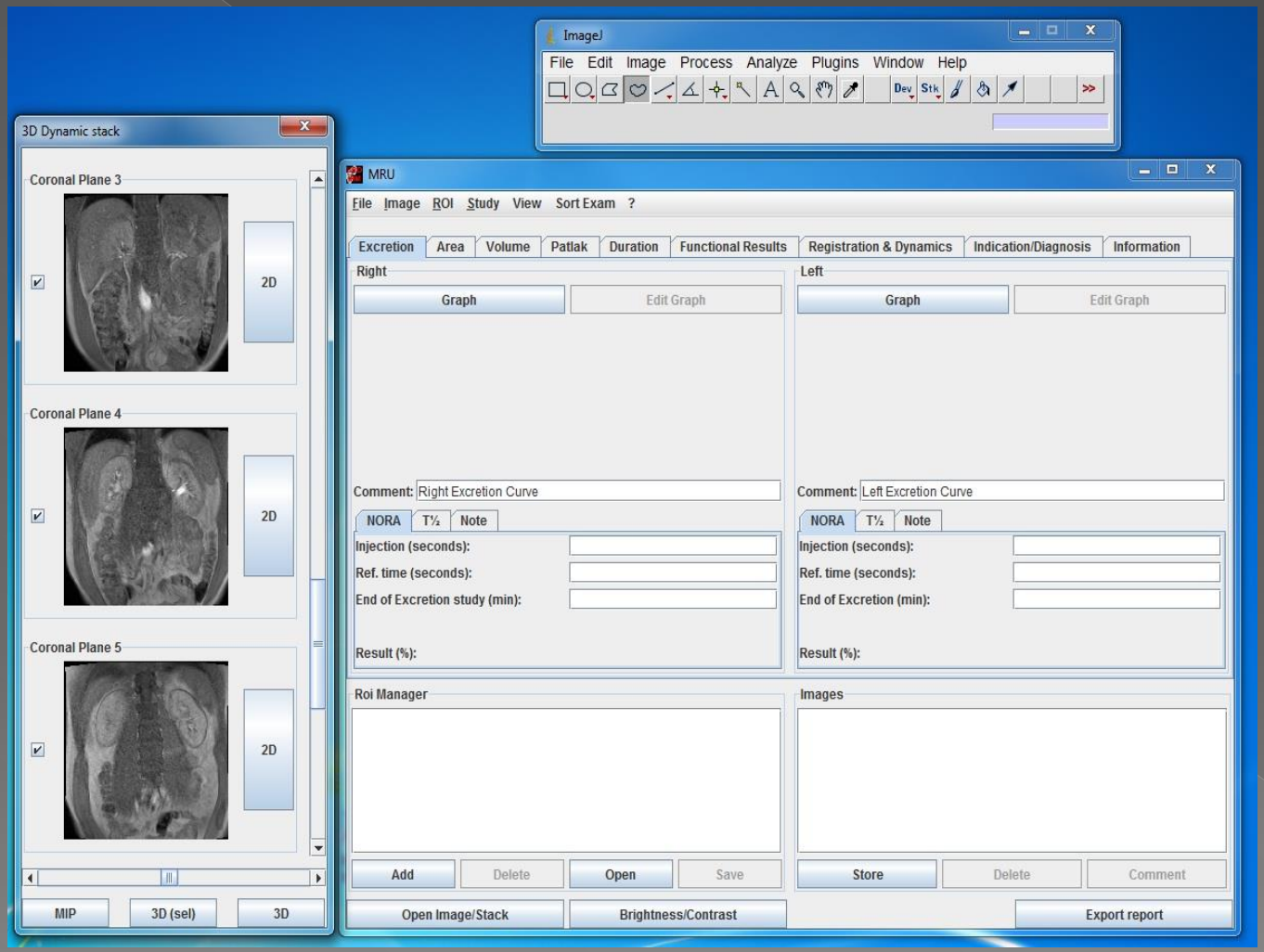
www.univ-rouen.fr/med/MRurography/accueil.htm

- CHOP-fMRU

Khrichenko D, Darge K. Pediatr Radiol (2010) 40:182–199.

www.chop-fmru.com

ImageJ PROGRAM



KIDNEY VOLUME

EXCRETION CURVE

SPLIT RENAL FUNCTION

TIME PERIODS

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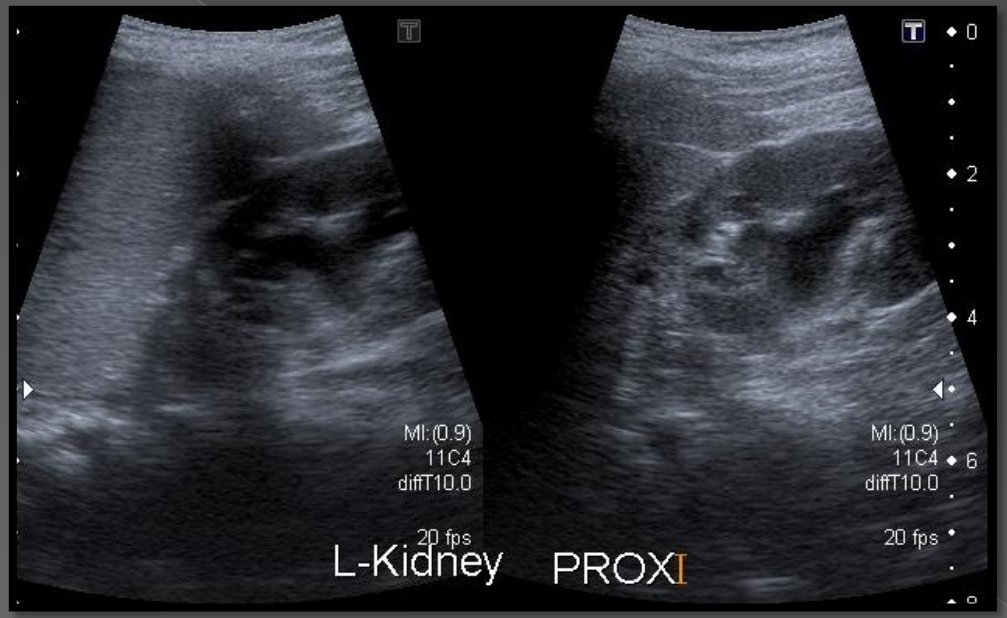
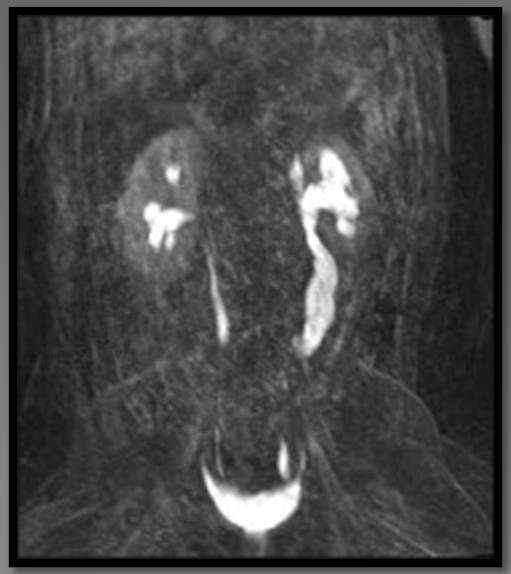
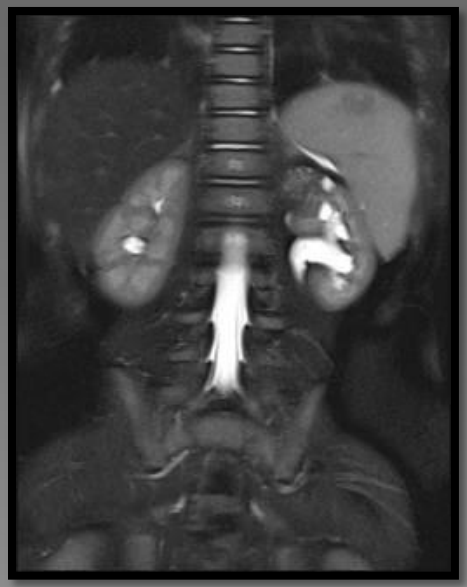
Kljucevsek D, MD, PhD, Radiology Unit, Children's hospital Ljubljana,

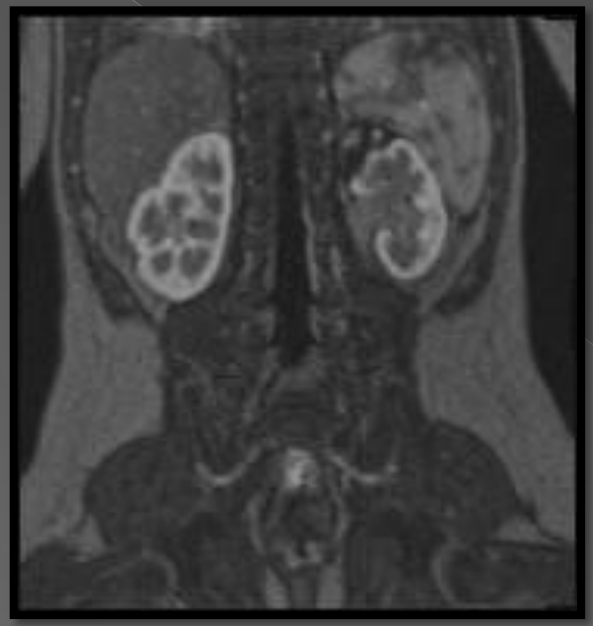
CASE 1

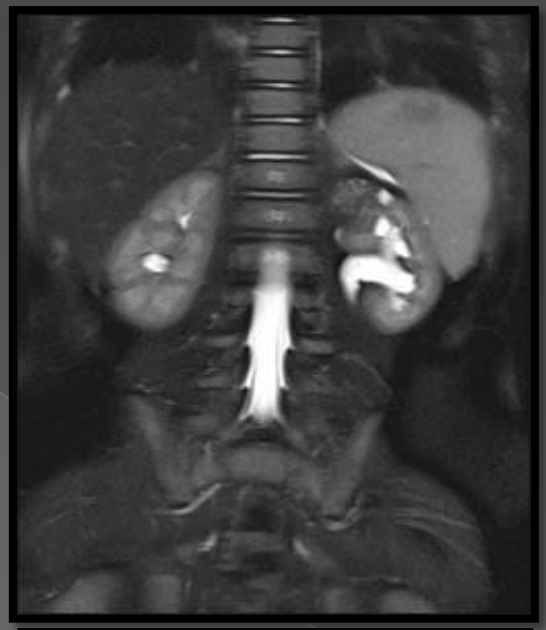

MI:(0.9)
11C4
diffT10.0
20 fps
L-Kidney
PROXI
MI:(0.9)
11C4
diffT10.0
20 fps

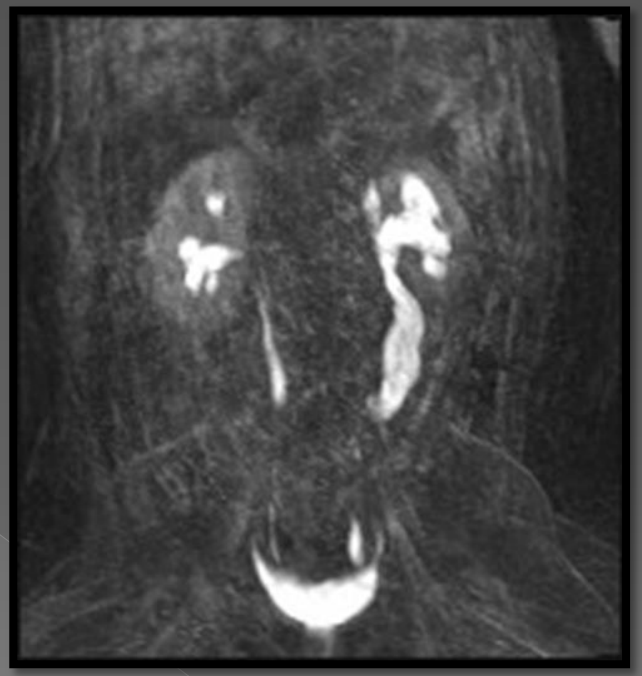


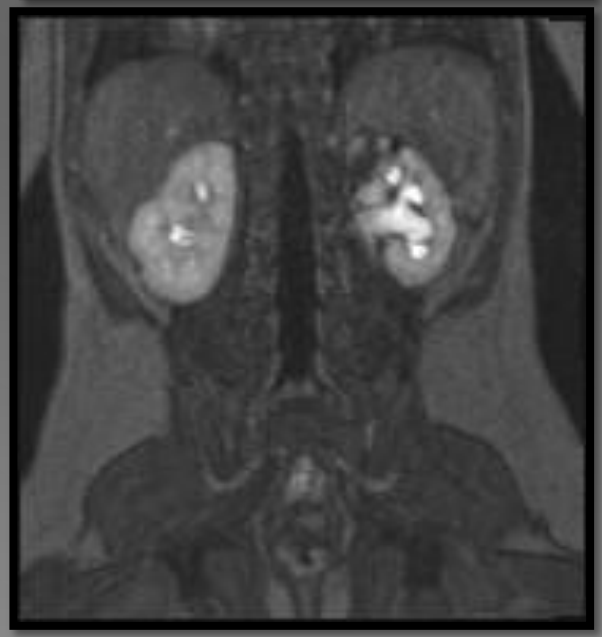


CASE 1









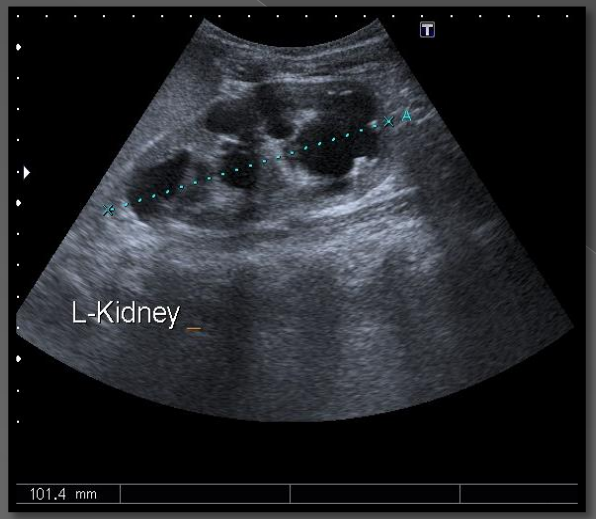
CASE 1

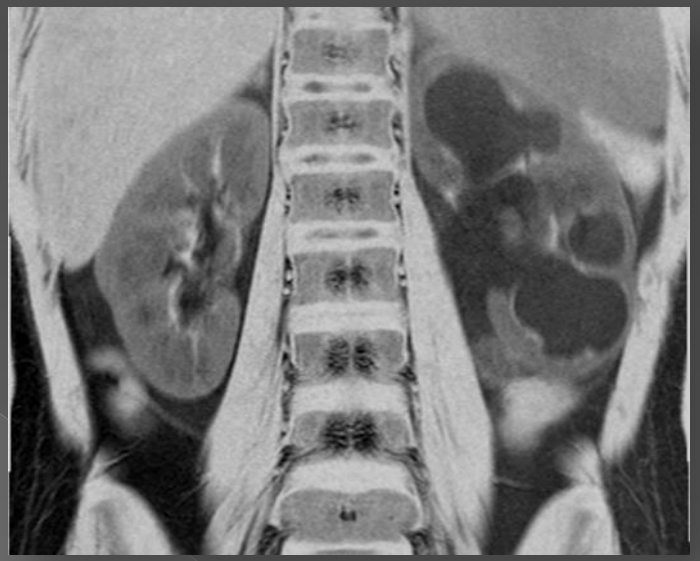
- double collecting systems on both sides with normal right kidney
- left kidney: dysplastic upper pole with very poor function, non obstructive hydronephrosis of lower pole
- no ectopic insertion of left ureters – both ureter end in bladder
- normal renal vessel anatomy

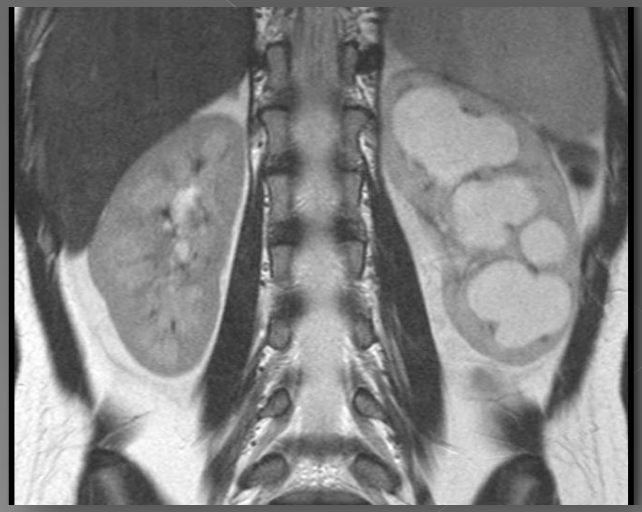
- Volume of RF 20 ml, LK 14 ml
- Excretion curve: normal on both sides
- Delayed excretion of CM in the upper pole of the left kidney
- Split Renal function: LK= 26%, RK=74%
- Therapy : heminephrectomiam of upper moiety of LK and neoimplantation of distal LU (Politano-Leadbetter)

- Renal Scintigraphy:
  manually calculated function of kidney
  LK= 28% RK= 72%

CASE 2



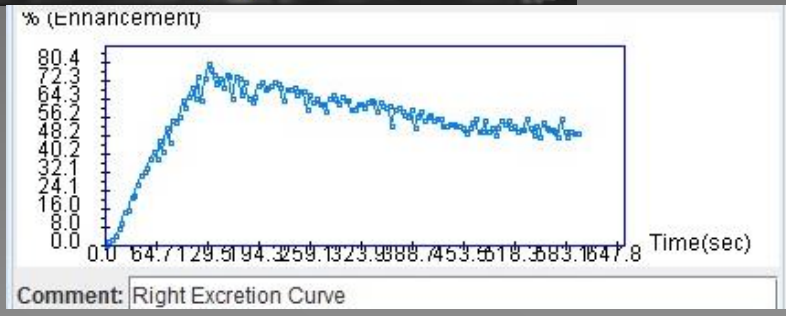


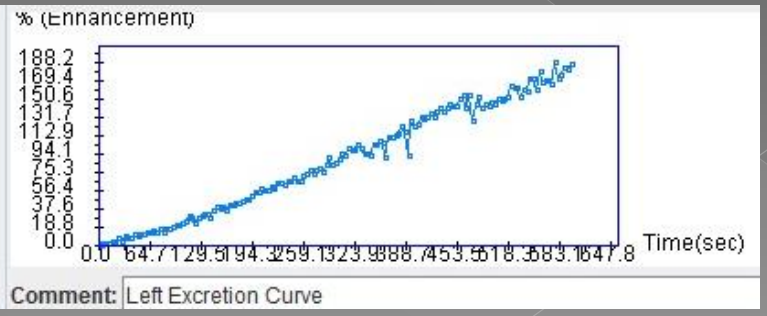


CASE 2


FA


FA


% (Enhancement)
80.4
72.3
64.3
56.2
48.2
40.2
32.1
24.1
16.0
8.0
0.0
0.0
Time(sec)
Comment: Right Excretion Curve


% (Enhancement)
188.2
169.4
150.6
131.7
112.9
94.1
75.3
56.4
37.6
18.8
0.0
0.0
Time(sec)
Comment: Left Excretion Curve

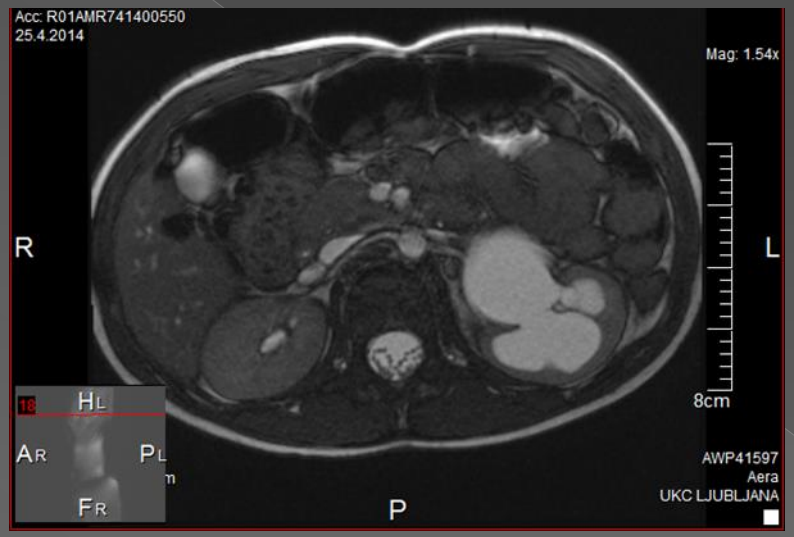
CASE 2

- HN gr. IV of LK

- Volume of RF 36 ml, LK 33 ml
- Excretion curve: RK – in accommulation , LK- in accommulation (obstruction)
- Split Renal function: LK = 48%, RK = 52 %
- Symmetric CTT (delayed on the left) and RTT more than 8 minutes – obstruction

- Renal Scintigraphy:
  manually calculated function of kidney
  LK= 41% RK= 59%

CASE 3


Acc: R01AMR741400550
25.4.2014
Mag: 1.54x
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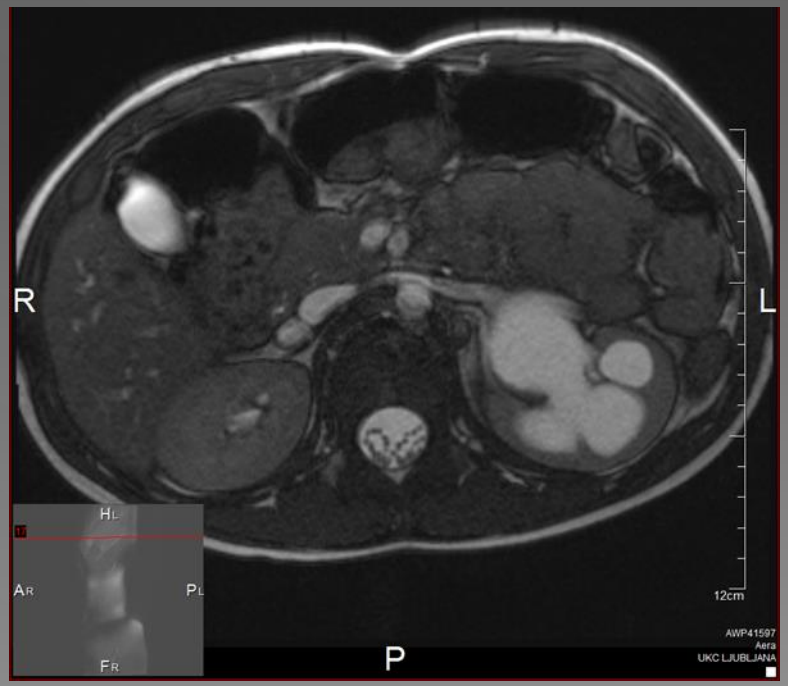
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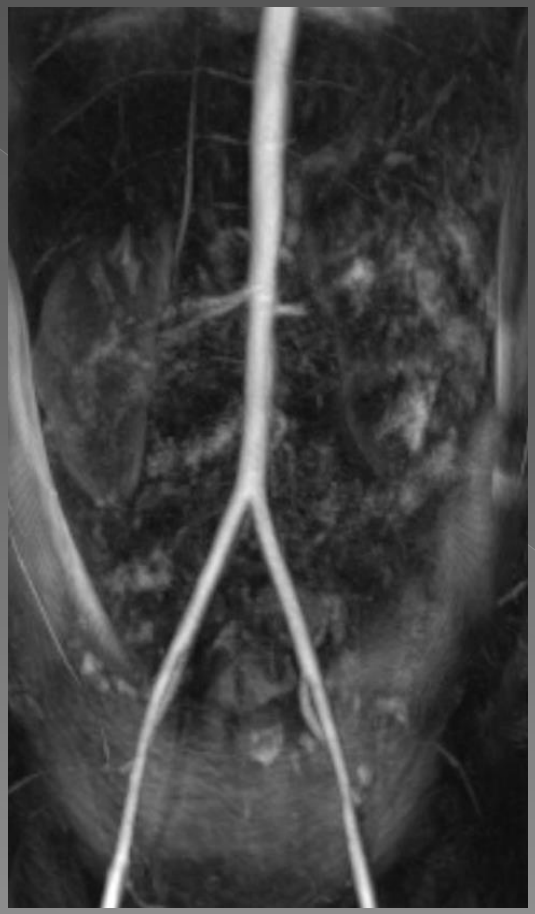
UKC LJUBLJANA




HP
FA

CASE 3

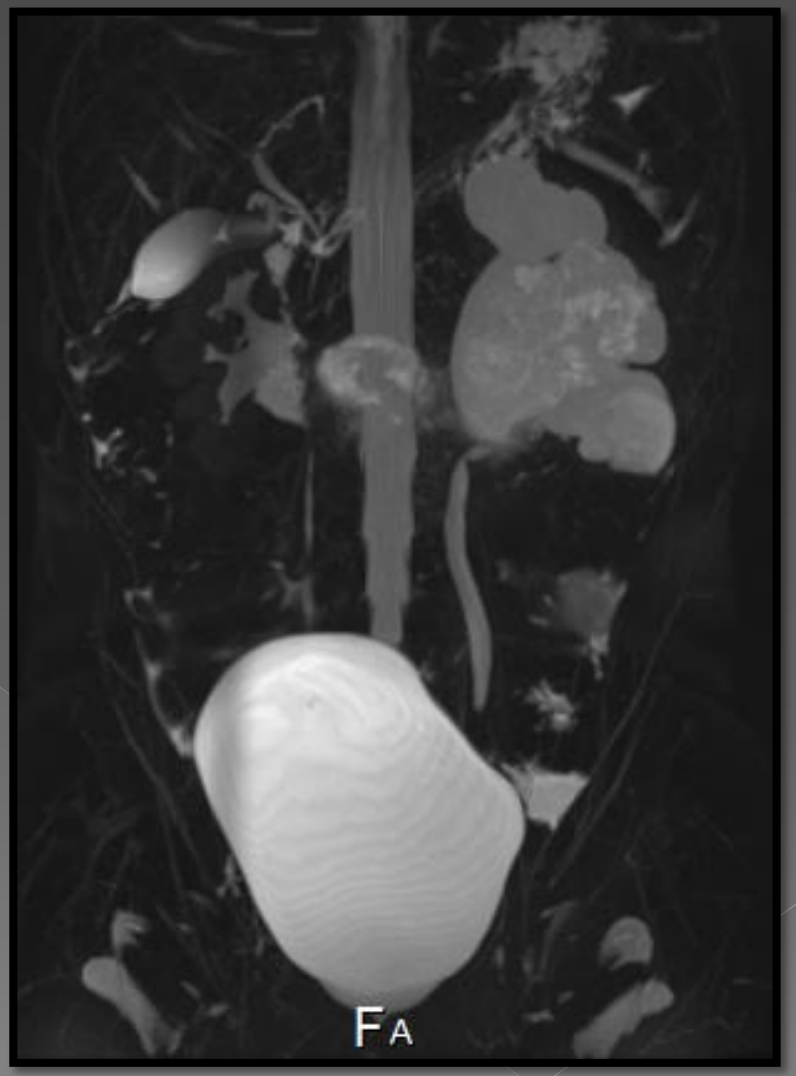
- HN gr. IV of LK with thinned and edematous renal parenchyma, lost corticomedular differentiation
- left PUJ is oriented posteriorly with kinking of proximal ureter
- information about renal vessels, no crossing vessel

- volume of RF 38 ml, LK 60 ml
- excretion curve: RK – normal, LK- in accommulation (obstruction)
- Split Renal function: LK = 77%, RK = 23 %
- asymmetric CCT (delayed on the left) and RTT more than 8 minutes – obstruction

- Renal Scintigraphy:

  manually calculated function of kidney

  LK= 25% RK= 75%



TAKE HOME MESSAGE

- US – first imaging method
- MRU - promising tool in evaluation of urinary system
- fMRU - „all in one method“ - with anatomic and quantitative functional information
- team work: radiologist, radiographer (MR specialist), nephrologist, urologist, nuclear medicine specialist, anesthesiologist

THANK YOU FOR LISTENING

MAGNETOM Aera
Transforming 1.5T economics.

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