

KIDNEY DISEASE VISUALIZED ON DIGITAL PROCESSOR

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Radiological methods of examination in diagnosis of pathological conditions and diseases of urinary system are numerous and various, reliable and dominant. They became indispensable and without competition, among other diagnostic methods, using the digital techniques. The aim of this paper was to present the radiological image of pathological conditions and diseases of urinary system diagnosed by intravenous urography using digital techniques and to show the diagnostic possibilities and importance of digital techniques in diagnostic radiology.

The paper analyzes pathological conditions and diseases of the kidney in a series of 3100 intravenous urographies (IVU) performed at the Radiology Center, Clinical Center Niš, during the period 2009-2012. Radiographic examination was performed on X-ray device with a TV chain Shimadzu. IVU was performed according to the standard protocol. Contrast media: Ultravist 370®. X-ray images were digitally processed in Agfa CR-30 digital processor.

The results are shown illustratively, by urographic images - anomalies, calculosis, hydronephrosis, tumors and other pathological conditions and diseases of the urinary system.

This paper presents numerous and various pathological conditions and diseases of the urinary system. Among the valuable radiological examination methods IVU has maintained a leading position. The usage of digital techniques made IVU faster, easy and efficient method of examination, while the obtained urograms are of satisfactory quality and adequate contrast visualization of the urinary system. *Acta Medica Medianae* 2013;52(3):35-41.

Key words: digital radiology, intravenous urography, urinary system, kidney

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in radiology contributed to the modernization of the radiology department, the transition from analog to electronic business, technology solution of complete information, etc. (11-21).

Introduction

Radiological methods in diagnosis of pathological conditions and diseases of the urinary system are numerous and various, reliable and dominant. They became indispensable and without competition, among other diagnostic methods, using the digital techniques (1-10). In diagnosis of pathological conditions and diseases of the urinary system are used numerous, various and valuable radiological methods of examination: plain abdominal radiography of the urinary tract, intravenous urography (IVU), renal and urinary bladder sonography, CT, MR, scintigraphy of urinary system, etc. (1-10). These radiological methods do not have the same possibilities or the same importance in the diagnosis of pathological conditions and diseases of the urinary system, while the digital technique made them powerful with available information at the right time and the basis of radiography remained the same as in analog radiology. The usage of digital technology

Backbone of digital radiography

The basis of digital radiography is the phosphor plate (instead of photo-sensitive foils coated with silver iodide), which has a latent X-ray image of an object illuminated by X-rays, for whose visualization is no longer required a photo lab to develop an x-ray film, but the scanner that first readout changes in phosphor layer plate, and deletes them in the returning, making it ready for use again. And a few thousand times like that. In a relatively short time radiographic image of the phosphor panel becomes available on the computer monitor, which can be further processed, copied, enlarged, sent etc.

Digital and analog X-ray image

Analog and digital x-ray images are in use in everyday radiology work.

Analog X-ray image is a radiology image recorded from the photosensitive foils on X-ray film at a certain time exposure.

Digital X-ray image is an X-ray image obtained in a form of one computer file i.e. in the form of the computer record at the time of exposure.

Pixel

The basic element of a digital image is pixel. Pixel characteristics are:

- Pixel size – Determined on the base of matrix size of digital images. The matrix size of modern X-ray equipment is 1024x1024. This means that each image is decomposed into small squares that make the network. They are arranged in rows and columns, 1024 in horizontal and 1024 vertical position. During the acquisition of a digital image each pixel location is determined in the image matrix. In a digital picture, the position of each pixel is defined in the file so it could be reconstructed on the screen in the place where it was noted during the acquisition i.e. obtaining of X-ray images;
- Shade gray scale, i.e. from black to white – Depending of the degree of X-ray absorption in the body and obtaining the X-ray image, every point i.e. pixel has its own gray shade from white to black. Besides the localization data of each pixel, in computer file of digital image is recorded also the data on the grayscale value of each pixel. When you run a digital image file, every registered pixel is put on its position with the degree of shades of gray, so that an X-ray image is shown on the screen.

How do you get a digital X-ray image?

Energy for receiving analog and digital X-ray image is in the X-ray. To obtain the analog and digital X-ray images, there are different media for detection of outgoing X-ray. In analog radiography it is an X-ray film or radiography while in digital X-ray images it is a screen for digitalization that is composed of photoelectric plates. The network of photoelectric plates covers the matrix and the size is one pixel. Each photoelectric plate is individually connected to the computer. When an X-ray hits one photoelectric plate it causes greater or lesser light effect. The emitted light produces electricity voltage proportional to the intensity of the emitted light. Then, the electric current is transported to the computer which defines the grayscale. The grayscale is registered for the photoelectric plate, i.e. pixel. Digital X-ray image is obtained by the fusion of all information from the input matrix.

Digital signal processor

Digital signal processors (DSP) are one of the innovations that have made rapid changes in people's lifestyle. DSP is the fastest growing segment of the semiconductor technology. Digital signal processors are microcomputers placed in a single chip, specifically designed for digital signal

processing algorithms created by the user. The advantage of the digital signal processor is a possibility to provide processing of the last received signal as much as possible until the new input signal comes.

DSP technology is the key for connection with the digital world.

Imaging software

Imaging software is specially designed for digital radiology. With one-touch on the keyboard all radiological examined patients during working hours will be shown on the computer screen. We can see on the screen all digital X-ray images of patients for the past time by selecting the patient and clicking with the mouse button. Each digital X-ray image can be viewed and analyzed using a simple and powerful tool, including contrast, brightness, measures, highlighting the selected picture regions. All patients digital X-ray images can be displayed on the same screen, so that we can compare them.

Customizable interface allows us to adapt the softer to our needs, with tools for changing the screen organization and language.

Advantage of digital radiology

Digital radiology has a number of advantages over analog radiology:

- The working process, beginning with the registration of a patient to obtaining digital X-ray image on the screen, is performed on a computer with immediate communication (without papers, forms, films, waiting, etc.);
- The efficiency of digital processors gives advantage to digital radiology instead of analog radiology;
- The important work automatisation is enabled;
- The powerful processing tool enables processing of X-ray image, X-ray image archiving, searching for archived X-ray images of patients.

Aim

The paper aims to present the radiological picture of pathological conditions and diseases of the urinary system diagnosed by intravenous urography (IVU) using the digital techniques and to indicate the diagnostic possibilities and value of digital techniques in diagnostic radiology.

Material and methods

This paper analyzes pathological conditions and diseases of the urinary system in a series of 3100 intravenous urographies (IVU) performed at the Radiology Center of Clinical Center "Niš" in Niš, during the period 2009-2012. Patients were examined on X-ray device with a TV chain "Schimadzu". Urograms were digitally processed in Agfa CR-30 digital processor. Contrast media: Ultravist 370®.

Results

The results are shown illustratively, by urographic images.

Figures 1a and 1b demonstrate unilateral, medial and pelvic ectopy of the left kidney. The left kidney has horizontal malrotation. The absence of the right kidney is congenital. Examination methods: native radiography of the urinary tract and intravenous urography. X-ray images are digitally processed in Agfa CR-30 digital processor. Native radiography of the urinary system is shown (1a). Urogram at 15 minutes (1b). Contrast media: Ultravist 370[®]. The shadow of the right kidney is absent. Left kidney is located low in the pelvis, medially, just above the urinary bladder, with reduced size, horizontally malrotated, with lower hilus orientation, functional, with a reduction of pyelocaliceal system, normal calyces and pyelons, while its ureter is with regular position and orifice, irregular flow, within normal parameters, patent. The urinary bladder has normal position, shape, sharp contours, homogenously filled with contrast media.

In Figure 2 the major calyx is elongated for the upper part of the right kidney. The ureter of the left kidney is fork-shaped. The adenoma of prostate is shown. Methods of examination: plain abdominal radiography of the urinary tract and intravenous urography. X-ray images are digitally processed in Agfa CR-30 digital processor. Urogram is shown at 15 minutes. Contrast agent: Ultravist 370[®]. The kidneys have proper position, shape, they are elongated, functional, pyelocaliceal system is conjugated with the domination of the lower system. The major calyx is elongated in the upper part of the right kidney. Right ureter has the normal position, flow, diameter, and is patent. The left ureter is forked at the level of the third lumbar vertebra (L3) with diameter in the normal parameters, patent. The bladder is in proper position, with sharply delineated contours, elevation of the arch base because of the enlarged prostate.

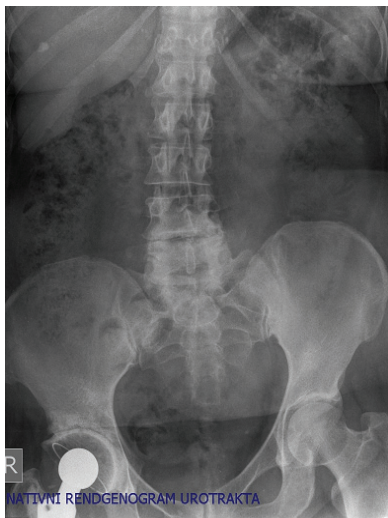


Figure 1a. Unilateral, medial and pelvic ectopy of the left kidney, native radiograph



Figure 1b. Unilateral, medial and pelvic ectopy of the left kidney, urogram at 15 minutes



Figure 2. Bilaterally duplicated and elongated kidneys



Figure 3. Movable right kidney

In Figure 3 (movable right kidney), the methods of examination are plain abdominal radiography of the urinary tract and intravenous urography. X-ray images are digitally processed in Agfa CR-30 digital processor. Urogram is shown at 15 minutes. Posture: standing. Projection: antero-posterior. Contrast media: Ultravist 370®. Right kidney is movable. The lower pole is set at the level of the fifth lumbar (L5) and the first sacral vertebra (S1) projection, functional, with branched pyelocaliceal system, regular calyces and pyelons, while its ureter has a sinuous course, the diameter is with normal parameters, sharply delineated contours, patent. The left kidney is orthotopic, properly shaped, functional, calyces and pyelons are normal, with normal urograph finding of the ureter. The urinary bladder is properly shaped, roughly outlined, and homogeneously filled with contrast agent.

The methods of bladder cancer (Figure 4) examination: plain abdominal radiography of the urinary tract and intravenous urography. X-ray images digitally processed in Agfa CR-30 digital processor. Urogram at 10 minutes. Contrast agent: Ultravist 370®. In the wall of the bladder, on the left, along the upper contour defect contrast ratio of diameter 5 cm, vaguely delineated contours, involving the ipsilateral orifice and leads to the exclusion of the left kidney. Right kidney and ureter with normal findings.

Upper urothelial tumor of the calyces of the upper part of the right kidney. Methods of examination: plain abdominal radiography of the urinary tract and intravenous urography. X-ray images digitally processed in Agfa CR-30 digital processor. Urogram at 15 minutes (5a). Targeted renogram of the right kidney is shown (5b). Contrast agent: Ultravist 370®. Pyelocaliceal system of the kidney is tripled. In calyces of the upper part of the kidney a soft tissue alteration is noticed that undermines the view of calyces. The major calyx in the upper part of the kidney is proximal to the absent lumen in the length of 2 cm. Left kidney, left ureter and urinary bladder show regular urography findings.

Figure 6a and 6b show left pyelonephritis with calculus. Methods of examination: plain abdominal radiography of the urinary tract and intravenous urography. X-ray images digitally processed in Agfa CR-30 digital processor. Native radiograph of the urinary tract is shown on (6a). Urogram at 15 minutes (6b). Contrast agent: Ultravist 370®. On the left, at the level of L2 is shadow, intensity of calcium, diameter around 10x4 mm corresponding to solitary inorganic calculi of the left canal system. Kidneys excrete the contrast media; the right kidney's excretion is timely and slower compared to the left one. Pyelocaliceal system of the right kidney is branched, with normal calyces and pyelons. Left pyelocaliceal system has deformed calyces. Ureters are regular and patent. The urinary bladder shows normal urography findings.



Figure 4. The bladder cancer

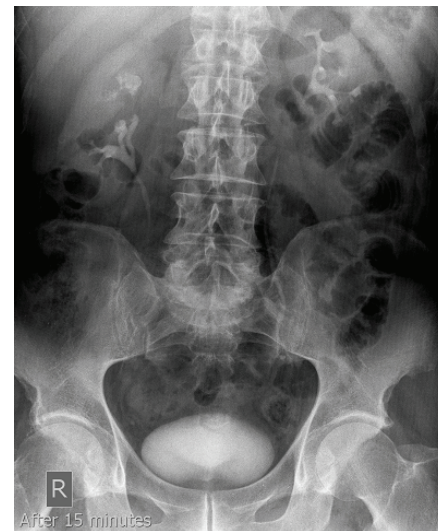


Figure 5a. Upper urothelial tumor of the calyces of the upper part of the right kidney - Urogram at 15 minutes



Figure 5b. Upper urothelial tumor of the calyces of the upper part of the right kidney - targeted renogram of the right kidney

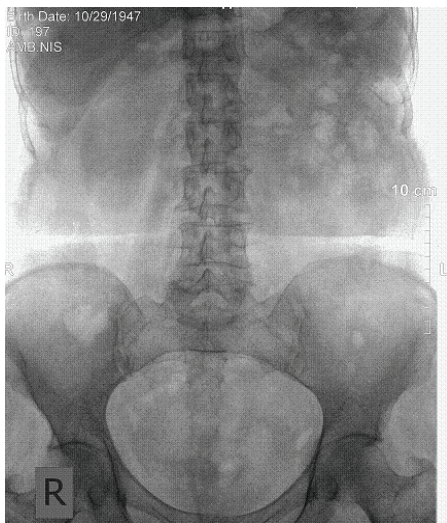


Figure 6a. Left pyelonephritis with calculus, native radiograph

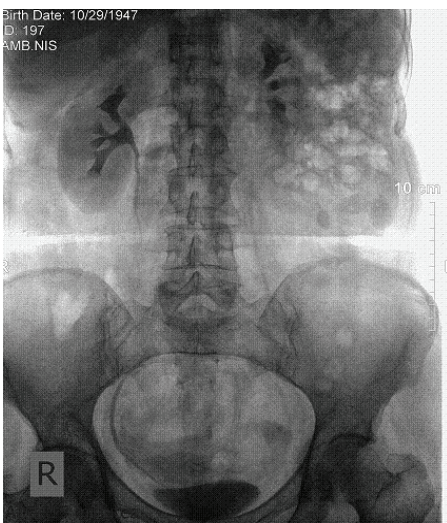


Figure 6b. Left pyelonephritis with calculus, urogram at 15 minutes

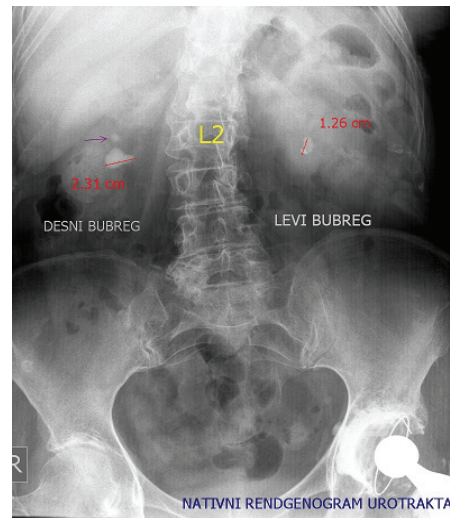


Figure 7a. Nephrolithiasis of the left and right kidney - native radiograph of the urinary tract

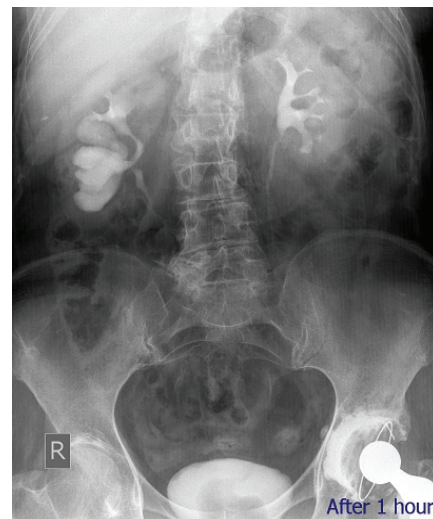


Figure 7b. Nephrolithiasis of the left and right kidney, right-sided hydronephrosis - urogram at 60 minutes

Figure 7a and Figure 7b show nephrolithiasis of the left and right kidney. Right-sided hydronephrosis. Methods of examination: plain abdominal radiography of the urinary tract and intra-venous urography. X-ray images are digitally processed in Agfa CR-30 digital processor. Native radiograph of the urinary tract is shown on (7a) and urogram at 60 minutes (7b). Contrast media: Ultravist 370®. On the both sides at the level of the second lumbar vertebra (L2) there are shadows with calcium intensity diameter of 23 mm, which correspond to multiple, inorganic concretions of pyelocaliceal systems of both kidneys. Kidneys are functional. Right pyelocaliceal system is dilated, calyces are obstructed. The calyces on the left are normal, except the calyx of the lower part of ipsilateral kidney which is deformed by concrement. The bladder has normal position, shape, sharply delineated contours and it is masked with intestinal contents.

Conclusion

This paper describes pathologic conditions and diseases of the urinary system diagnosed by

IVU standard protocol, visualized by digital processor. Among the valuable radiological examination methods, IVU has maintained a leading position. Each and even a minimum quantity of any intra-venous application of iodine contrast media can lead to a number of adverse reactions that endanger the health and lives of patients. Application of digital technology has made IVU fast, easy and efficient method of examination. The obtained urograms are with satisfactory quality, contrasting and adequate visualization of the urinary system. Compared to analog radiology, the digital radiology has a significant advantage: the working process starting with the registration of a patient until obtaining of digital x-ray images is performed on a computer with instant communication, that is paperless, without forms, films, and waiting; the digital processor with its efficiency favors the digital over the analog radiology; it provides automation of the work processes; the powerful tools allow processing of digital X-rays images etc.

References

1. Babić RR, Bašić B, Govedarović K, Đinđić B, Stanković Babić G, Marković Perić S. Intravenska urografija posle pripreme bolesnika simethicon-om (Espumisan®). *Acta Medica Medianae* 2011; 50 (1): 38-43. [\[CrossRef\]](#)
2. Babić RR, Mitrović D. Tumori gornjeg urotelijuma – radiološka prezentacija. In: Strahinjić S, editor. *Balkanska endemska nefropatija i endemski balkanski tumori gornjeg urotelijuma. Retrospektiva 1941-2011*. Niš: Galaksija; 2011. p. 124-9.
3. Babić RR. Balkanska endemska nefropatija – imidžing dijagnostika. In: Strahinjić S, Čukuranović R, Pavlović N, Babić R, editors. *Balkanska endemska nefropatija 50 godina naučnoistraživačkog rada 1957-2007*. Niš; 2007.
4. Babić RR. Radiološke metode pregleda u dijagnostici patoloških stanja i oboljenja urosistema. *Acta Medica Medianae* 2004; 2: 53-7.
5. Babić RR. Izuzetno retki varijeteti anomalija urosistema – rendgenološka prezentacija. *Acta Medica Medianae* 2002; 4: 71-9.
6. Babić RR, Milatović S, Mitrović D, Mitov S. Rendgeno loški aspekti nefrokalcinoze. *RAS* 2002; 11 (2): 125-7.
7. Babić RR, Babić MR, Milatović S, Radovanović Z, Mrvić M, Đoršević V, et al. Incidenca i vrste neželjenih reakcija na jodno kontrastno sredstvo pri urografiji. *RAS* 2000; 2: 91-8.
8. Babić RR, Petković V, Radovanović Z, Milatović S, Babić MR, Đorđević V, et al. Izgled pijelokaliksnog sistema pri urografiji kod izvesnih stanja i oboljenja bubrega. *RAS* 1999; 2: 217-25.
9. Babić RR. Neželjene pojave od kontrastnih sredstava pri urografiji sa predlogom mera za smanjenje rizika [disertacija]. Beograd: Univerzitet u Beogradu.; 1998.
10. Vidić P. Maligni tumori bubrega - prikazani ultrasono grafijom i kompjuterizovanom tomografijom. *RAS* 2003;12 (1): 7-14.
11. Pejinović P. Digitalizacija u radiološkoj dijagnostici. *RAS* 2002; 11(1): 31-4.
12. Nikolić G. Digitalizacija rendgenske slike [Internet]. 2011 "cited 2013 May 24"; 6 p. Available from: URL: http://gorannikolic.me/uploads/Digitalizacija_rendgenske_slike._STUDENTI_TEKST.pdf
13. Berković I, Miličević V. Porcesiranje rendgenskih digitalizovanih snimaka – kontrast [Internet]. Zrenjanin: Tehnicki fakultet „Mihajlo Pupin“ 2011 "cited 2013 May 24". Available from: URL: <http://www.telfor.rs/telfor2005/radovi/OS-5.9.pdf>
14. Petljanski B. DSP-Digital Signal Procesor. 2011.
15. Praskalo J, Vulin N. Informacione tehnologije u radiologiji. *INFOTEH-JAHORINA* 2010; 9: 909-12.
16. Babić RR. Bolesti bubrega vizualizovane digitalnim procesorom. In: Strahinjića S, Babića R, editors. *Prevenција bubrežnih bolesti*. Niš: Medicinski fakultet; 2012. p. 319-23.
17. Babić RR, Babić S, Marjanović A, Pavlović Radojković. Virtualni svet kompjutera u prevenciji bubrežnih bolesti. In: Strahinjića S, Babića R, editors. *Prevenција bubrežnih bolesti*. Niš: Medicinski fakultet; 2012. p. 329-38.
18. Babić RR. What does BIRADS provide in Mammo graphy? *Acta Fac Med Naiss* 2011; 28 (1): 25-31.
19. Babić RR, Milošević Z, Stanković-Babić G. Web technology in health information system. *Acta Fac Med Naiss* 2012; 29 (2): 81-7.
20. Babić RR, Milošević Z, Stanković-Babić G. Tele radiology – Radiology at distance. *Acta Fac Med Naiss* 2012; 29 (3): 145-51.

BOLESTI BUBREGA VIZUALIZOVANE DIGITALNIM PROCESOROM

Rade R. Babić

Radiološke metode pregleda u dijagnostici patoloških stanja i oboljenja urosistema su brojne i raznovrsne, suverene i dominantne, koje su primenom digitalne tehnike među drugim dijagnostičkim metodama postale neizostavne i bez konkurencije. Rad ima za cilj da prikaže radiološku sliku patoloških stanja i oboljenja urosistema dijagnostikovanu intravenskom urografijom primenom digitalne tehnike i da ukaže na dijagnostičke mogućnosti i vrednost primene digitalne tehnike.

U radu se analiziraju patološka stanja i oboljenja bubrega na seriji od 1.500 intravenskih urografija (IVU) urađenih u Centru za radiologiju Kliničkog centra u Nišu, tokom perioda od 2009. do 2010. godine. Rendgenološki pregled je rađen na rendgen aparatu sa TV lancem Schimadzu. IVU je rađena po standardnom protokolu. Kontrastno sredstvo: Ultravist 370®. Urogrami su digitalno obrađivani na Agfa CR-30 digitalnom procesoru.

Rezultati rada prikazani su ilustrativno, slikama uograma – anomalije urosistema, kalkuloza urosistema, hidronefroza, tumori urosistema i druga patološka stanja i oboljenja urosistema.

U radu su prikazna brojna i raznovrsna patološka stanja i oboljenja urosistema. Među vrednim radiološkim metodama pregleda IVU je zadržala vodeću poziciju. Primena digitalne tehnike učinila je IVU brzom, laganom i efikasnom metodom pregleda, dok su dobijeni urogrami zadovoljavajućeg kvaliteta, kontrastnosti i adekvatne vizualizacije urosistema. *Acta Medica Medianae 2013;52(3):35-41.*

Ključne reči: *digitalna radiologija, intravenska urografija, urosistem, bubreg*