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Duplex-Doppler ultrasound of intrarenal arteries in the assessment of the percutaneous transluminal angioplasty of renal artery stenosis – A case report

Boris Brkljačić,[1] Andrija Hebrang,[2] Ivan Drinković[1]

[1] Ultrasonic Center and [2] Interventional Division, Department of Radiology, University Hospital Merkur, Medical School of the University of Zagreb, Croatia

A case is presented where the color duplex-Doppler sonography of intrarenal arteries was used for the assessment of success of percutaneous transluminal angioplasty of renal artery stenosis. Spectral waveform analysis from intrarenal arteries in a case of angiographically proven renal artery stenosis, with the diameter reduction >80 %, has shown spectra with prolonged systolic acceleration time and increased diastolic flow (parvus and tardus type). After the angioplasty had been performed intrarenal arterial spectra have returned to normal forms, with normal systolic acceleration time and normal diastolic flow. Duplex-Doppler spectral analysis can be used for the assessment of the outcome of percutaneous transluminal angioplasty in cases of hemodinamically significant renal artery stenosis.

Key words: renal artery obstruction; angioplasty, balloon; renal artery – ultrasonography; ultrasonography, Doppler, duplex

Introduction

Hemodynamically significant renal artery stenosis (RAS) causes activation of the renin-angiotensin system and leads to the renovascular hypertension with deleterious effects on cardiovascular system and the kidney.[1] Percutaneous transluminal angioplasty (PTA) is a preferred noninvasive means of the treatment of RAS, which obviates the need for surgery, thus reducing surgical and anesthetical risks, as well as the price of the treatment.[2] Duplex-Doppler sonography of main renal arteries has several significant drawbacks in the detection of RAS.[3, 4] However, duplex-Doppler of intrarenal arteries is much easier and quicker to perform[5] and this method may have a significant role in detection, as well as evaluation of therapy of RAS. We present a patient who was examined by color-duplex Doppler ultrasound (CDD US) of intrarenal arteries to evaluate the success of the PTA of renal artery in a case of a hemodinamically significant RAS.

Correspondence to: Dr. sc. Boris Brkljačić, Ultrasonic Center, Department of Radiology, University Hospital »Merkur«, Zajčeva 19, 10000 Zagreb, Croatia; Tel/Fax + 385-1-2331-440.

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Patients and methods

A 42 years old male patient with a history of hypertension, lasting for several months, with

maximal blood pressure values of 220/130 mmHg. Complete clinical work-up was performed, and, eventually, the patient was submitted to conventional selective renal angiography with renin measurements. These results showed significant left renal artery stenosis, with the reduction of the vessel diameter >80%. Patient was referred to our hospital for PTA of the left renal artery.

One day before the procedure patient was examined by color duplex-Doppler ultrasound (CDD US) of renal and intrarenal arteries. One day after the PTA was performed the patient was reexamined by CDD US.

Conventional US and CDD US of both kidneys was performed with a color-Doppler scanner (Radius CF, GE-CGR, Buc, France) with a curved array 3.75 MHz transducer. The patient was examined in both instances by the first author. Examinations were performed in supine and semioblique positions, and the duration of each examination was around 20 minutes. Intrarenal interlobar and arcuate arteries were insonated in the upper and the lower pole of the kidney, sample volume positioned with help of the color, and spectral waveform analysis performed. In insonated arteries, form of spectra was evaluated qualitatively, regarding systolic acceleration time and diastolic flow. Main renal arteries could not have been adequately visualized due to the excessive amount of air in bowels. Only the small segment of right main renal artery was analyzed, and left renal artery was not visualized at all. The wall filter was set usually at 50 Hz, and the sample volume was 1–3 mm wide. Hard-copies of spectral waveforms were obtained by a Hitachi color-video printer.

Prior to PTA, selective digital subtraction angiography (DSA) of the left renal artery was performed on a Siemens DSA machine. After the selective catheterization of the left renal artery, a teflon coated 0.035″ guidewire of 140 cm length (Angiomed) was introduced. A 5.5 F balloon catheter (Angiomed) with a balloon diameter of 6 millimeters was introduced over the guidewire. The balloon was filled three times under the pressure of 7 atm. During the angioplasty the guidewire was left in the segmental renal artery branch. Immediately after the angioplasty a control angiography was performed. The duration of the procedure was 20 minutes. Post-procedure compression of the puncture site of the common femoral artery was performed for 10 minutes.

Results

CDDUS of intrarenal arteries performed one day before angioplasty showed spectra with prolonged systolic acceleration time and increased diastolic flow in the left kidney. A name "parvus and tardus waveform" has been proposed by Stavros for this type of spectral waveforms.[6] The diastolic flow was increased compared to normal intrarenal waveforms. In the right kidney, which was angiographically normal, the normal morphology of spectra was noted in intrarenal arteries, with sharp systolic rise and short systolic acceleration time, and with continuous antegrade diastolic flow.

The spectrum from the intrarenal arteries of the left kidney with RAS is shown in the Figure 1.

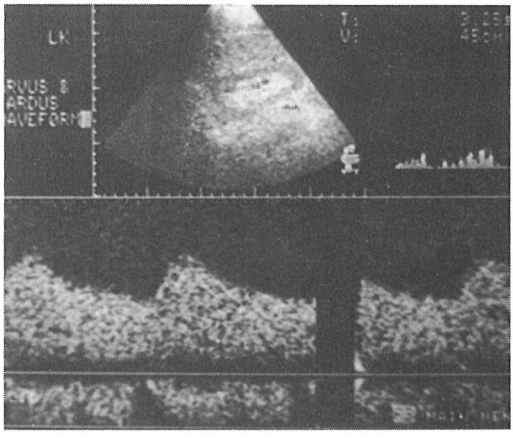

Figure 1. US image of a typical "parvus and tardus" spectral waveform in intrarenal arteries of a kidney with a hemodinamically significant RAS, with reduced pulsatility, slow systolic rise and prolonged acceleration time, and increased diastolic flow.

The selective DSA of the left renal artery confirmed conventional angiographic finding of a high-grade (> 80 %) stenosis in the proximal segment of the left main renal artery. The selective DSA of the left renal artery prior to the performance of the PTA is shown in the Figure 2.

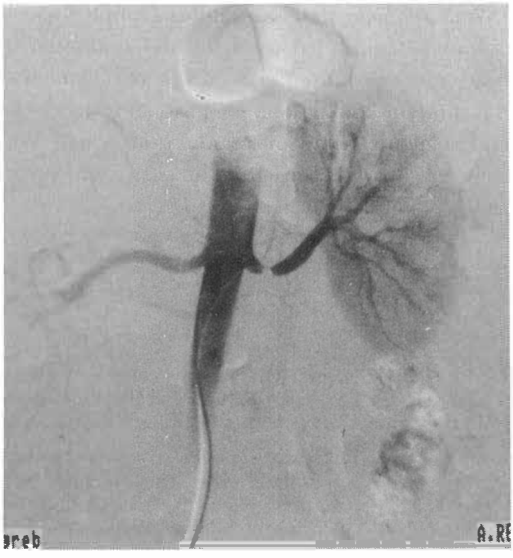

Figure 2. The selective DSA of the left renal artery showing a high-grade (> 80 %) stenosis in the proximal segment of the left main renal artery.

The PTA of the left renal artery was technically successful, and the angioplasty was performed without any complications during or after the procedure. The immediate post-PTA selective DSA of left renal artery is shown in the Figure 3. It showed normal arterial lumen with only minor marginal filling defect.

Thirty hours after the angioplasty had been performed CDDUS of intrarenal arteries showed normal forms of intrarenal spectra, with sharp systolic rise and normal systolic acceleration time, with reduction of diastolic flow as compared to pre-procedure spectra. Post-procedure normal spectra in intrarenal arteries are shown in the Figure 4.

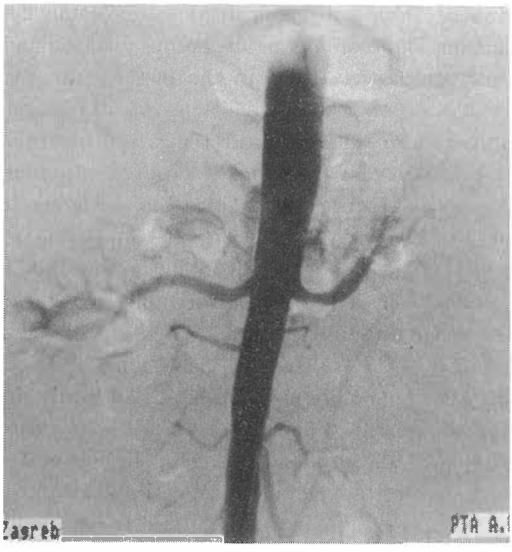

Figure 3. The selective DSA of the left renal artery immediately after the PTA was performed. The arterial lumen was almost completely restored, with only minor marginal filling defect.

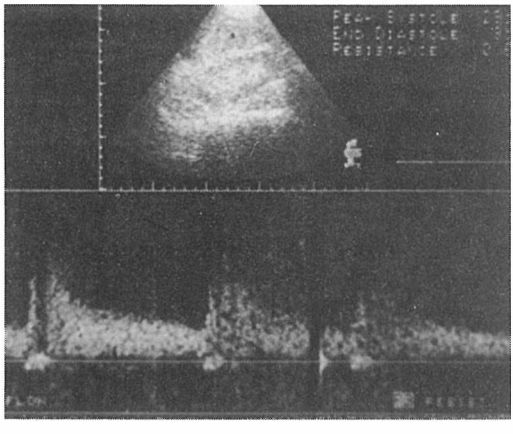

Figure 4. US image of the normal intrarenal spectra, with normal pulsatility, sharp systolic rise and normal acceleration time 30 hours after the angioplasty had been performed.

Discussion

The color duplex-Doppler US has enabled the visualization of flow in intrarenal vessels, and has considerably facilitated the performance of spectral waveform analysis and the quantifica-

tion of Doppler signals from these vessels.[4, 5] Duplex-Doppler US of intrarenal arteries has been extensively used in the last decade for evaluation of flow in transplanted kidneys and native kidneys, for diagnosis of renal obstruction, renal vein thrombosis, differentiation of benign and malignant renal masses and in diagnosis of various parenchymal kidney diseases.[5, 7–11]

Several papers have been published about the usage of duplex-Doppler US in the diagnosis of renal artery stenosis, and the data about the sensitivity and the specificity of the method vary considerably between different studies.[3, 6, 12–14] Although the first studies were very enthusiastic, claiming significant clinical usefulness of the method, latter studies have shown much lower sensitivities and specificities, and the method is nowadays not considered too useful for the evaluation of the RAS. There are several obstacles, like obesity, gas in the bowel, two or more renal arteries on one or both sides, etc. These shortcomings of the method are extensively discussed in the literature. However, CDDUS analysis of intrarenal arteries is technically much easier, and can be successfully performed in all patients if the examination technique is optimal and if the examiner is experienced. One can expect that spectral waveform alterations in intrarenal arterles should be clearly detectable in cases of hemodinamically significant stenosis "upstream", in the main renal artery. This high-grade stenosis produces a pressure drop which is manifested downstream as a spectrum of reduced pulsatility, with increased diastolic flow and increased systolic rising time. Such spectrum has been named "parvus and tardus type" by Stavros.[6]

In this paper we have presented a case of the patient with angiographically proven high-grade stenosis in proximal main renal artery, with "parvus and tardus" spectra in intrarenal arteries. After the percutaneous transluminal dilatation had been successfully performed, the intrarenal spectra returned to normal forms. In this case the difference between these spectra is clearly visible and qualitative spectral analysis was sufficient for the diagnosis, so that the spectral quantification need not have been performed. This observation is in accordance with the study of Harshfield, et al, who observed that in the cases where there were discrepancies between the post-PTA angiographic an Doppler waveforms, the Doppler waveforms correlated better with blood pressure response than the anatomic appearance of the rental arteriogram.[15]

We conclude that the duplex-Doppler spectral analysis can be used for the noninvasive assessment of the success of the percutaneous transluminal angioplasty in cases of hemodinamically significant renal artery stenosis. We believe that CDDUS should be performed prior and after PTA of renal artery stenosis.

References

1. Smith MC, Dunn MJ. Renovascular and renal parenchymal hypertension. In: Brenner BM, Rector FC eds. *The kidney*, 3rd edition. Philadelphia: W.B.Saunders Co, 1986: 1221–53.
2. Thomsen HS, Pollack HM. The genitourinary system. In: Pettersson H ed. *A global textbook of radiology*, Vol I, Oslo: NICER Institute, 1995: 1186–7.
3. Sievers KW, Loehr E, Werner WR. Duplex Doppler ultrasound in determination of renal artery stenosis. *Urol Radiol* 1989; **11**: 142–7.
4. Neiman HL. The urinary system. In: Goldberg BB ed. *Texbook of abdominal ultrasound*. Baltimore: Williams & Wilkins, 1993; 330–91.
5. Platt JF, Ellis JH, Rubin JM. Examination of native kidneys with duplex-Doppler ultrasound. *Seminars in ultrasound, CT and MRI* 1991; **12**: 308–18.
6. Stavros T, Thomas ET, Teplick SK, et al. Segmental stenosis of the renal artery: pattern recognition of tardus and parvus abnormalities with duplex sonography. *Radiology* 1992; **184**: 487–92.
7. George EA, Salimi Z, Wolverson MK, Garvin PJ. Assessment of renal allograft pathology by scintigraphic and ultrasound index-markers. *Clin Nucl Med* 1991; **16** (6): 394–8.
8. Ramos I, Taylor KJW, Kier R, et al. Tumor vascular signals in renal masses: detection with Doppler US. *Radiology* 1988; **168**: 633–7.
9. Taylor KJW, Ramos I, Carter D, Morse SS, Snower DP, Fortune KL. Correlation of Doppler US tumor signals with neovascular morphologic features. *Radiology* 1988; **166**: 57–62.

10. Brkljačić B, Drinković I, Sabljar-Matovinović M, et al. Intrarenal duplex-Doppler sonographic evaluation of unilateral native kidney obstruction. *J Ultrasound Med* 1994; **13**: 197–204.

11. Brkljačić B, Mrzljak V, Drinković I, et al. Renal vascular resistance in diabetic nephropathy: duplex-Doppler US evaluation. *Radiology* 1994; **192**: 549–54.

12. Patriquin H. Stenosis of the renal artery: assessment of slowed systole in the downstream circulation with Doppler sonography. *Radiology* 1992; **184**: 479–85.

13. Harshfield DL, Teplick SK, Stavros T. Further observation of renal artery stenosis and renovascular hypertension. *Radiology* 1994; **193** Suppl: 393.

14. Halpern EJ, Needleman L, Nack TL. Early systolic acceleration (ESA) as indicator of renal artery stenosis. *Radiology* 1994; **193** Suppl: 255.

15. Harshfield DL, Teplick SK, Grigg K, Stavros T. Intra- and periprocedural duplex US to monitor results of renal artery angiography. *Radiology* 1994; **193** Suppl: 398.