Percutaneous transluminal renal angioplasty application effect on renal function in patients with renal artery stenosis – a case report on 4 patients

Uticaj primene perkutane transluminalne renalne angioplastike na funkciju bubrega kod bolesnika sa stenozom bubrežne arterije


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Abstract

Introduction. Renal artery stenosis (RAS) is narrowing of one or both renal arteries or their branches. Clinically significant stenosis involves narrowing of the lumen, which is approximately 80%. The two most common causes of its occurrence are atherosclerosis and fibromuscular dysplasia. Percutaneous transluminal renal angioplasty (PTRA) with stent implantation is an effective treatment modality that leads to lower blood pressure and improvement of kidney function. Case report. We presented 4 patients with significant stenosis of one or both renal arteries followed by the development of arterial hypertension and renal insufficiency. The causes of RAS were atherosclerosis in two patients and fibromuscular dysplasia in one patient. One of the patients had renal artery stenosis of transplanted kidney that developed 9 month after transplantation. In all the patients, in addition to clinical signs, doppler screening suspected the existence of significant renal artery stenosis. The definitive diagnosis was made by applying computed tomographic angiography (CTA) of renal arteries in 3 of the patients and in 1 patient by percutaneous selective angiography. All the patients were treated by application of PTRA with stent implantation followed by improvement/normalization of blood pressure and kidney function. Conclusion. Application of PTRA with stent implantation is an effective treatment of significant stenosis of one or both renal arteries followed by renal insufficiency.

Key words: renal artery obstruction; kidney function tests; diagnostic techniques and procedures; angioplasty, balloon.

Apstrakt


Ključne reči: a. renalis, opstrukcija; bubreg, funkciji testovi; dijagnostičke tehnike i procedures; angioplastika, balonska.

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Introduction

Renal artery stenosis (RAS) is narrowing of one or both renal arteries or their branches. Clinically significant stenosis involves narrowing of the lumen, which is approximately 80%, resulting in renal hypoperfusion, activation of the renin-angiotensin system, increase in systemic blood pressure and reduction of the glomerular filtration rate. The two most common causes of RAS are atherosclerosis and fibromuscular dysplasia (FMD). Atherosclerotic renal artery stenosis (ARAS) is common in adults older than 65 years with hypertension, generalized atherosclerosis disease and renal impairment, as the main clinical signs. The reported prevalence of clinically manifested ARAS in the general population is 0.5% overall and 5.5% among patients with chronic kidney disease. Since patients are often asymptomatic, the actual frequency is higher and ranges up to 7%.

Unlike ARAS, FMD is a nonatherosclerotic and noninflammatory vascular disease that most commonly affects the renal and internal carotid arteries but has been described in almost every arterial bed in the body, occurring frequently in young women. Diagnosis of RAS can be set using various functional and morphological tests. Duplex ultrasonography is noninvasive tool which provides a functional assessment of the severity of stenosis because higher velocity correlates with a greater pressure differential across the stenosis. Renal angiography using computed tomography (CTA) or magnetic resonance (MRA) are noninvasive and sophisticated diagnostic techniques. Sensitivity/specificity of these methods is an average of 64/92% for CTA and 62/84% for MRA. In patients with chronic kidney disease, the use of CTA and MRA are limited by toxicity of the contrast medium or risk from development of nephrogenic systemic fibrosis, associated with gadolinium. The gold standard to diagnose RAS still remains digital-subtraction angiography but it is invasive diagnostic procedure with risks from different vascular complications.

While the application of percutaneous dilatation is an effective modality of treatment FMD, optimal therapy of ARAS is still controversial.

The aim of this case reports was to show the effect of applying PTRA with stent implantation on renal function in four patients with significant renal artery stenosis. Under significant stenosis we assumed renal artery lumen narrowing greater than 70%. Two patients had atherosclerotic RAS, one patient FMD and one patient had renal artery stenosis of transplanted kidney. In all the patients endovascular intervention led to the normalization or improvement of renal function.

Case 1

A 57-year-old former smoker, with the history of arterial hypertension, abdominal aneurism and renal insufficiency was admitted with following signs and symptoms: shortness of breath, edema and oliguria. Laboratory findings showed an increase in serum creatinine from 230 to 881 μmol/L, with normal results of urine. Hemodialysis treatment was initiated through a central venous catheter. A total of four procedures was carried out, by means of which we achieved a good control of blood pressure and decreased values of serum creatinine to 365 mmol/L. Ultrasound examination revealed the right kidney of reduced size (8.2 cm), with thin parenchyma (0.7 cm) and without doppler signal. Left kidney diameter was 11.5 cm, with thin parenchyma in the upper half of the kidney -0.9 cm, without doppler signal. In the lower half of the left kidney parenchyma was a 1.6 cm and intrarenal doppler examination showed that the resistive index (RI) was 0,45. Based on clinical features and the finding of a low RI, the patient was suspected to having significant stenosis of the left renal artery. Multislice computed tomography (MSCT) arteriography was performed and diagnosed the existence of the sclerotic right kidney with an occluded artery, while the left kidney had two arteries. Artery in the upper half was occluded and the artery of the lower half had subtotal stenosis/narrowing of more than 95% lumen. By the interventional radiologist the patient underwent percutaneous transluminal renal angioplasty (PTRA) with dilation and implantation of a stent size 3 × 18 mm in the artery to the lower half of his left kidney. The achieved response was well and clinically manifested in the...
decline of serum creatinine value of 222 μmol/L at discharge and normalization of blood pressure values, which with application of antihypertensive medications was 130/70 mmHg. Interventional procedures and time to discharge passed without complications.

Case 2

A 61-year-old smoker was admitted due to worsening of arterial hypertension with a max. value of blood pressure up to 180/110 mmHg. Laboratory analysis showed elevated serum creatinine, which amounted to 121 μmol/L. Ultrasound finding in the kidneys was normal. Intrarenal doppler obtained the normal value of RI, which in the right kidney was 0.65, and 0.64 in the left kidney. MSCT angiography was done. We diagnosed infrarenal localized abdominal aortic aneurysm and significant stenosis of the left renal artery to 1.5 cm from the ostium (Figure 2a). The right kidney was vascularized with 2 arteries. The artery for the upper half of the right kidney had significant stenosis at 1 cm from the ostium (Figure 2b). We applied PTRA to the left renal artery with dilation and implantation of two stents of the dimension of 6 × 18 mm and obtained an excellent angiographic response (Figure 2c). A month following the previous, we performed PTRA to the significantly narrowed one of the existing two right renal arteries, with dilation and implantation of a stent size 3.5 × 18 mm (Figure 2d). Both interventions were performed without complications. After the treatment, the patient had normal values of blood pressure and creatinine, which was 93 μmol/L at discharge.

Fig. 2 – The case 2: (a) significant stenosis of the left renal artery before percutaneous transluminal renal angioplasty (PTRA); (b) significant stenosis of the artery for the upper half of the right kidney before PTRA; (c) the left renal artery after PTRA; (d) the artery for the upper half of the right kidney after PTRA
Case 3

A 43-year-old patient was admitted due to worsening of arterial hypertension, with a maximum value of blood pressure 240/130 mmHg and the development of renal insufficiency with serum creatinine value of 148 \( \mu \text{mol/L} \). The personal history showed that the patient had subarachnoid bleeding in February 2008. Angiographic examination diagnosed the presence of an aneurysm of \textit{a. communicans cerebri anterior}. Embolization was done.

Ultrasound examination revealed the right kidney of reduced-size (7 cm), with thin parenchyma (0.7 cm) and without doppler signal. The left kidney diameter was 11.2 cm, normal width of parenchyma (1.6 cm) and intrarenal doppler examination showed that the RI was 0.41. Based on clinical features and the finding of low RI, the patient was suspected to having significant stenosis of the left renal artery. MSCT arteriography was performed and diagnosed the existence of the sclerotic right kidney with the graceful and ocluded right renal artery (Figure 3a). The left renal artery had numerous stenosis, with classic “string of beads” appearance (Figure 3b). By the intervention radiologist, the patient underwent PTRA with three dilations, but there was no satisfactory angiographic response, so a stent size \( 3 \times 30 \text{ mm} \) was placed (Figure 3c). Interventional procedure was performed without complications. At discharge the patient had normal value of serum creatinine which was 102 \( \mu \text{mol/L} \) and normal blood pressure of 120/80 mmHg, by applying an antihypertensive medication.

Case 4

A 37-year-old patient, with living-related kidney transplantation 9 months before, was admitted because of deterioration of the function of renal graft. Laboratory findings showed an increase in serum creatinine from 130 to 286 \( \mu \text{mol/L} \), which coincided with the introduction of antihypertensive drugs from the group of ACE inhibitors. The extra renal doppler examination showed the peak sistolic velocity of 280 cm/s at the site of anastomosis of the renal and hypogastric artery. We performed percutaneous renal angiography

Fig. 3 – The case 3: (a) ocluded right renal artery; (b) the left renal artery with the classic “string of beads” appearance before percutaneous transluminal renal angioplasty (PTRA); (c) the left renal artery after PTRA
and diagnosed the significant (narrowing of 85% lumen of artery) annular stenosis at the site of anastomosis. Interventional radiologist performed dilation with implantation of a stent size 5 × 20 mm. After the procedure there was a decline in serum creatinine, the value of which at discharge was 150 μmol/L. The patient was regularly controlled and graft function was stable. In June 2009, due to worsening of blood pressure, restenosis was suspected. MSCT angiography showed stent patency, with no signs of stenosis (Figure 4).

Discussion

The optimal therapeutic treatment of ARAS is still unclear. Until now randomized clinical studies comparing the effects of combined application of balloon angioplasty with stent implantation and drug therapy as opposed to the application of drug therapy alone, have shown no significant higher survival rate of patients in the first group 14–16. There is an ongoing largest, multicenter, randomized, controlled clinical trial on 1080 patients, CORAL (Cardiovascular Outcome in Renal Atherosclerotic Lesions) study, with better defined criteria for treatment of renal artery stenting, the aim of which is to avoid shortcomings of previous studies. The results of this study are expected by the end of 2011. Until completion of the results the CORAL study, endovascular intervention should be implemented only in patients with tight RAS of the single functioning kidney or with bilateral stenosis in patients with recurrent pulmonary oedema or when arterial hypertension is refractory to medication with rapid reduction of renal function. The presence of a small, sclerotic kidney is an obvious contraindication for endovascular intervention 17.

Two of the patients with atherosclerotic RAS were older, with signs of generalized atherosclerotic disease, including the existence of abdominal aortic aneurysm. In both patients there were clear indications for implementation of PTRA and stent implantation. In the first patient there was significant ostial stenosis of the single functioning kidney, followed by rapid deterioration of renal function and the development of hypervolemia with the signs of heart failure. Kane et al. 18 demonstrated that renal artery revascularization resulted in improved heart failure control and reduction in the number of hospitalizations. In the patient number 2 there was significant bilateral renal artery stenosis accompanied by refractory arterial hypertension and worsening of renal function. Ischemic damage led to no reduction in kidneys size. Upon completion of the treatment in both patients there was an improvement or normalization of renal function, so good control of blood pressure was achieved.

In contrast to ARAS, FMD is more common in younger female persons and changes typically occur in the middle or distal arterial segments 19. The cause is less than 10% of cases of renovascular hypertension. In addition to renal artery, FMD can occur in the cerebral and visceral arteries, and may clinically manifest as arterial hypertension, stroke, abdominal angina and Claudications. The incidence of unruptured intracranial aneurysms in patients with FMD vary widely, from 7% to more than 50% 20. Percutaneous balloon angioplasty is a therapeutic modality of treatment in patients with poorly regulated arterial hypertension and renal failure. Stent implantation is applied in the case of obtaining suboptimal response or dissection of renal artery 21.

In our patient number 3 the diagnosis of renal artery FMD was preceded by subarachnoid hemorrhage caused by rupture of aneurysm a. communicans cerebri anterior. Renal artery stenosis is clinically manifested by resistant arterial hypertension and the development of acute renal failure. Although the loss of renal mass occurs in up to 63% of patients with renal-artery FMD, renal failure is rare in these patients 22. Occurrence of acute renal failure in our patients may be partly explained by the existence of a hypoplastic right kidney. After applying PTRA we obtained a suboptimal angiographic response, which was the reason for stent implantation. After the treatment the patient achieved normalization of blood pressure and kidney function.

Renal transplant artery stenosis is often an unrecognized vascular complication that can occur several months and years after kidney transplantation. The published incidence ranges from 1% to 23% depending on the criteria used for diagnosis 23. It occurs more frequently at the anastomotic site compared with the distal part of donors artery. 24. Stenosis is usually manifested as difficult-to-treat hypertension, with deterioration of renal function, in the absence of rejection, recurrence of primary disease, calcineurins toxicity, infections and ureteral obstruction 25–28. Duplex-Doppler examination is the ideal test for screening and follow-up of stenosis. Balloon-angioplasty is a therapeutic method of choice in comparison with surgical revascularization and drug therapy 29, 30.

In our patient number 4 the graft renal artery stenosis was diagnosed 9 months after the renal transplantation. Transplantation was complicated with endarterectomy of hypogastric artery of recipient and thrombosis at the anastomosis. It was the reason to do thrombectomy and reanastomosis. The above surgical complication probably represented the predisposing factor for the development of stenosis. Graft renal artery stenosis manifested with deterioration of its
function, which coincided with the application of drugs from the group of ACE inhibitors. Findings obtained by doppler examination indicated the presence of stenosis at anastomosis. We applied percutaneous selective angiography and confirmed the existence of significant annular stenosis of the renal artery at anastomosis. At that time our institution had no MSC. After application of PTRA with stent implantation graft function improved. At outpatient control, the patient maintained stable graft function 7 years after the transplantation. The value of creatinine was 124 μmol/L at the last ambulatory control in June 2011.

**Conclusion**

In patients with acute or worsening chronic renal insufficiency, the existence of significant stenosis of one or both renal arteries should be considered. Timely application of PTRA in these patients leads to preservation of renal function.

**REFERENCES**


Received on July 26, 2011. Accepted on January 10, 2012.