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Immediate and long-term results of the use of balloon angioplasty with stenting in the treatment of renal graft arterial stenosis

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Abstract

Aim. *To assess the safety and efficacy of percutaneous transluminal balloon angioplasty with stenting for renal graft artery stenosis.*

Material and methods. *From June 2018 to December 2022, 344 kidney transplants from a deceased donor were performed at the surgical clinic of City Clinical Hospital n.a. S.P. Botkin. The study group consisted of 220 men (63.9%) and 124 women (36.1%). The mean age was 46.46±11.74 (19-73) years. With a mean follow-up period of 20.05 (1-54) months, stenosis of the renal graft artery was diagnosed in 4 patients (1.16%). The mean time from transplantation to the diagnosis of stenosis was 4 (1-9) months. In*

addition, we diagnosed the development of this complication in 4 kidney transplant recipients operated in other centers. The mean time from transplantation to the diagnosis of stenosis in these patients was 103.25 (12-221) months. Thus, we have the experience in the treatment of renal transplant arterial strictures in 8 recipients: 4 men (50%) and 4 women (50%). The mean age was 48.25±11.97 (27-60) years. Stenosis was manifested by renal graft dysfunction with a progressive increase in urea and creatinine in 6 patients (75%), by arterial hypertension in 2 patients (25%). The mean, level of creatinine at the time of diagnosing stenosis was 290.75 (157-494) μmol/L, glomerular filtration rate was 22.87±12.19 (8-41) ml/min/1.73m^2.

Results. *In the early postoperative period, 1 complication was recorded in the form of pulsating hematoma of the common femoral artery, which required surgical intervention (complication class IIIA according to Clavien-Dindo). The mean hospital postoperative bed-days made 5.22 (4-8). The mean follow-up time was 22.75±7.4 (14-33) months. All recipients were alive throughout the whole follow-up period. In 7 of 8 recipients (87.5%), the graft was functioning, in 1 patient a progressive graft dysfunction was noted, for which chronic hemodialysis was started. Mean creatinine in recipients with a functioning graft was 156.71±33.4 (123-200) μmol/L; mean glomerular filtration rate was 41.57 ml/min/1.73m^2.*

Conclusions. *Percutaneous transluminal balloon angioplasty with stenting is a safe and effective minimally invasive technique and should be considered as the operation of choice in the development of renal graft artery stenosis.*

Keywords: kidney transplantation, renal graft artery stenosis, balloon angioplasty with stenting

Conflict of interests Authors declare no conflict of interest

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BA, balloon angioplasty

CFA, common femoral artery

GFR, glomerular filtration rate

IR, insulin resistance

MSCT, multislice spiral computed tomography

USE, ultrasound examination, ultrasonography

Introduction

Renal graft artery stenosis is a rare vascular complication after kidney transplantation, which incidence varies from 1% to 23% according to the world literature [1]. Clinical manifestations of this complication are variable: from asymptomatic course to acute renal failure [2]. In the early stages after transplantation, the development of this complication is associated with trauma to the donor or recipient arteries, or with the technical difficulties of arterial reconstruction [3]. In the late post-transplant period, stenosis is most often associated with atherosclerotic lesions of the graft or recipient arteries [4]. Doppler ultrasound and computed tomography with intravenous contrast are of the greatest importance in the diagnosis and determination of patient treatment tactics [5]. Most experts give the main role to percutaneous transluminal balloon angioplasty (BA) in the treatment of this complication

[6, 7]. However, a high incidence of restenoses has been reported with BA without stenting, it is 16–62%, while with stenting, the incidence of restenosis makes 10% [7]. Although the long-term results of using this technology are ambiguous due to the small sample of patients in study series. We did not find publications on this problem in the Russian medical literature; therefore, in our study, we retrospectively analyzed our experience of using BA with stenting in the treatment of renal graft artery stenosis.

Material and methods

From June 2018 to December 2022, 344 kidney transplants from a posthumous donor were performed in the Surgical Clinic of the City Clinical Hospital named after. S.P. Botkin. There were 220 men (63.9%) and 124 women (36.1%). The median age was 41 (interquartile range: 24–68) years. Kidney explantation from a post-mortem donor, transplant surgery and immunosuppressive therapy in the post-transplant period were performed according to standard protocols, in accordance with the National Clinical Guidelines. In all cases, the end-to-side arterial anastomosis was formed between the renal graft artery and the recipient external iliac artery by using monofilament 5-0 or 6-0 non-absorbable suture. In standard situations, the renal artery was anastomosed together with the Carrel patch in case of severe atherosclerotic lesions of the graft renal artery orifice and/or the excess length of the artery, the Carrel patch was excised.

At a median follow-up of 16 (interquartile range: 2–50) months, clinically significant renal graft artery stenosis was diagnosed in 4 patients (1.16%). The median time from transplantation to diagnosing stenosis was 6 (interquartile range: 1–8) months. In addition, we diagnosed the development of this complication in 4 kidney transplant recipients operated

on in other centers. The median time from transplantation to diagnosis of stenosis in these patients was 94 (interquartile range: 18–200) months. Thus, we have the experience in the treatment of arterial stenosis in 8 kidney transplant recipients (Fig. 1, 2).

Fig. 1. The small pelvis image at computed tomogram with intravenous contrast. Stenosis of the renal graft artery at the orifice (yellow arrow)

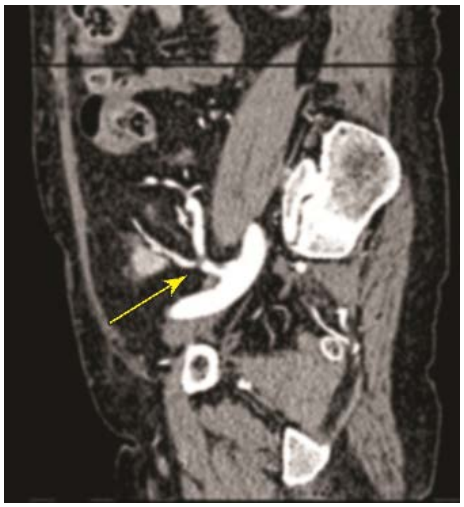

Fig. 2. The small pelvis image at computed tomogram with intravenous contrast. Stenosis of the renal graft artery in the middle third (yellow arrow)

Of these, there were 4 men (50%) and 4 women (50%). The median age was 44 (interquartile range: 32–62) years. Stenosis was manifested by renal graft dysfunction with a progressive increase in urea and creatinine levels in 6 patients (75%), and arterial hypertension resistant to therapy in 2 patients (25%). The mean creatinine level at the time they were diagnosed with stenosis was 290.75±119.06 (157–494) μmol/L, the glomerular filtration rate (GFR) was 22.87±12.19 (8–41) ml/min/1.73 m^2.

Percutaneous transluminal balloon angioplasty with stenting was performed according to the following protocol. In the X-ray Operating Room under local anesthesia, the puncture and catheterization of the common femoral artery (CFA) on the side of the lesion was performed, a 6F introducer was placed, a 0.035–260 cm guidewire was inserted into the CFA, and a guiding catheter of the JR 6A type was placed in the external iliac artery (Fig. 3).

Fig. 3. Angiogram. Stenosis of the renal graft artery at the orifice (yellow arrow)

A guidewire of 0.014–190 cm was passed behind the stenosis zone, in case of severe stenosis and difficulty in inserting the stent, the stenosis was predilated using a balloon catheter; then the positioning and implantation of the balloon-expandable renal Hippocampus RX stent was performed (Fig. 4). In case of a marked residual stenosis of more than 30%, a post-dilation in the stent was performed with a balloon catheter. After that, control angiography was performed (Fig. 5). Then the arterial introducer was removed and a pressure bandage was applied. In case of ostia stenosis, the renal stent was positioned under fluoroscopy guidance using the Roadmap mode, without the proximal end of the stent entering the lumen of the external iliac artery.

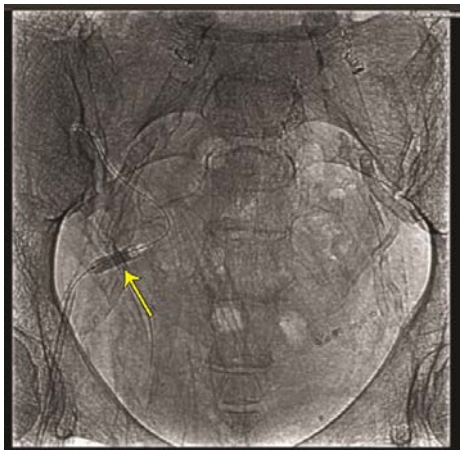

Fig. 4. Angiogram. Renal graft artery stent placement (yellow arrow)

Fig. 5. Control angiogram after the renal artery stent placement

Subsequently, all recipients received dual antiplatelet therapy in the amount of clopidogrel 75 mg/day, and acetylsalicylic acid 100 mg/day for at least 6 months. On the 1st day, the pressure bandage was removed, a control ultrasound examination (USE) was performed to determine the resistive index of blood flow and its dynamics in the segmental arteries of the renal graft. To determine the clinical efficacy of the technique under study, we assessed changes in creatinine and GFR before the procedure and at the time of follow-up. The technical efficacy of the procedure was understood as the successful implementation of BA and subsequent stent placement by endovascular surgeon.

Statistical data processing

Statistical processing and data analysis were performed using the IBM SPSS Statistics software, 26 version. With a normal distribution, the data were expressed as the means, standard deviations, 95% CI; in a distribution differed from normal, the data were reported indicating the medians, interquartile ranges. Changes in creatinine and GFR before the procedure

and at the time of follow-up were made using the Student's T-test for related samples with the determination of the statistical significance level (p-value). Differences were considered statistically significant at $p \leq 0.05$.

Results

In the early postoperative period, 1 complication was recorded: CFA pulsating hematoma requiring surgical intervention of suturing the CFA defect (Clavien-Dindo severity grade IIIb). The mean postoperative bed-day was 5.22±2.23 (4–8) days.

The mean follow-up period was 22.75±7.4 (14–33) months. All recipients were alive throughout the whole follow-up period. In 7 of 8 recipients (87.5%), the graft functions. In 1 patient, a progressive graft dysfunction was noted for which chronic hemodialysis was started. Mean creatinine in recipients with a functioning graft was 156.71±33.4 (123–200) μmol/L, mean GFR was 41.57 ml/min/1.73 m^2. Improvements in creatinine and GFR after the BA procedure with stenting were statistically significant (p=0.008 and p=0.019, respectively) (Fig. 6, 7).

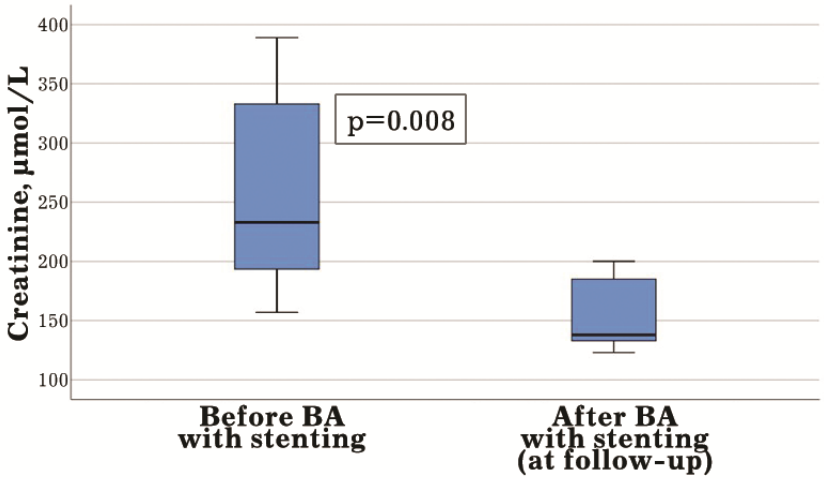

Fig. 6. Creatinine dynamics in renal transplant recipients before and after stenting for renal artery stenosis

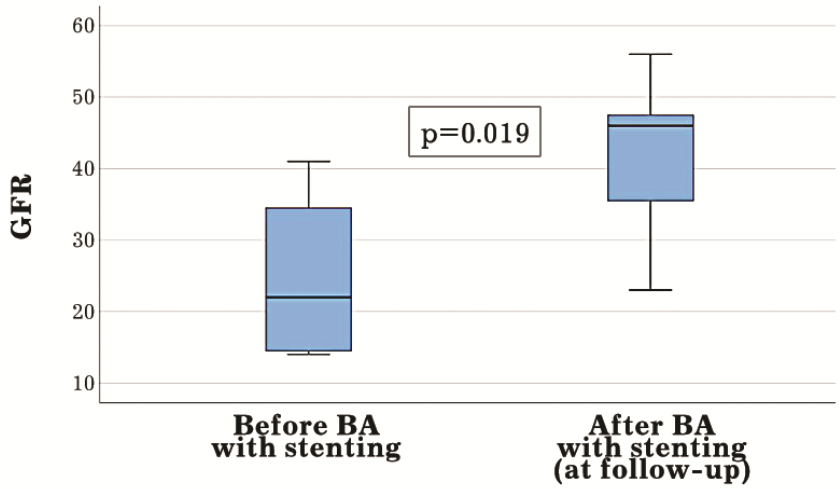

Fig. 7. Dynamics of glomerular filtration rate in renal transplant recipients before and after stenting for renal artery stenosis

Discussion

Stenosis of the renal graft artery is a rare complication, which at the same time can lead to the loss of the kidney graft. According to our data, renal graft artery stenosis can occur both in the early postoperative period (up to 3 months) and in the late postoperative period (more than 3 months). Most often, this complication is manifested by renal graft dysfunction (75%), less often by treatment-resistant arterial hypertension (25%). Thus, when examining patients with renal graft dysfunction, it is necessary to be aware of the possible development of renal artery stenosis. Ultrasound of the renal graft with Doppler sonography may yield findings to suspect stenosis in most cases, and if so, there is a decrease in the vascular resistance index. Meanwhile, in the prestenotic zone of the main trunk, the peak systolic blood flow velocity will be higher than normal; in the post-stenotic zone, blood flow of the "tardus et parvus" type can be recorded with significantly increased acceleration time. In the presence of clinical manifestations and a typical ultrasonographic signs of arterial stenosis, in no contraindications, it

is advisable to perform computed tomography of the pelvic organs with intravenous contrast. This investigation allows verifying the diagnosis, identifying the location and extent of stenosis, thereby determining the indications for percutaneous transluminal BA with stenting, as well as to select the required type of stent.

According to our data, percutaneous transluminal BA with stenting is a safe and effective treatment for renal graft artery stenosis: technical efficiency was 100%, clinical efficacy was 87.5%, and postoperative complications were 12.5%.

We consider it important to dwell separately on the case of clinical inefficacy of X-ray endovascular treatment for renal graft artery stenosis. Patient D., aged 49, underwent cadaveric kidney transplantation in January 2003. She was referred to the Transplantation Department the City Clinical Hospital named after S.P. Botkin in connection with the progressive kidney graft dysfunction for her placement on the waiting list for re-transplantation. Her data on admission were as follows: creatinine 494 μmol/L, GFR 8 ml/min/1.73 m^2, insulin resistance (IR) 0.41; with multislice spiral computed tomography (MSCT) demonstrated stenosis up to 85% of the middle third of the renal graft artery for which BA with stenting was performed giving a satisfactory technical result (Fig. 8).

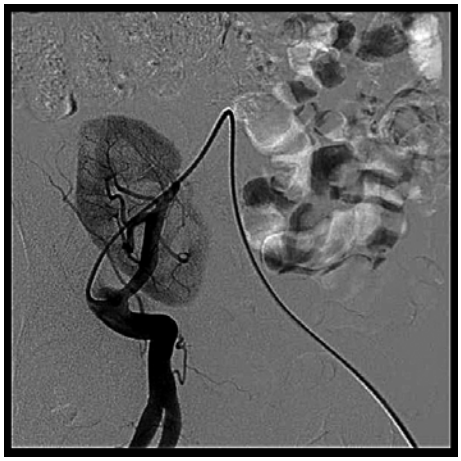

Fig. 8. Control angiogram after renal artery stenting

In the postoperative period, the patient was diagnosed with a pulsating hematoma in the puncture area, which required surgical intervention in the extent of suturing the defect of the common femoral artery. In the period of follow-up, a further increase in blood creatinine and a decrease in GFR were recorded, which required the initiation of renal replacement therapy at 2 months after stenting. Retrospectively, long-term stenosis of the renal graft artery had led to irreversible changes in the renal parenchyma, and therefore stenting did not produce a desired result.

In the remaining kidney transplant recipients, no episodes of dysfunction were recorded during the dynamic follow-up period. In 2 kidney transplant recipients, the arterial hypertension was stopped after stenting of arterial stenosis. In all recipients with a functioning kidney graft, GFR increased statistically significantly during follow-up period ($p=0.019$) (Fig. 7). No restenoses were recorded at follow-up.

Therefore, percutaneous transluminal BA with stenting is a safe and effective technique for the treatment of renal graft artery stenosis, which makes it possible to statistically significantly improve GFR and prolong the

long-term kidney graft survival.

Conclusions

1. Percutaneous transluminal balloon angioplasty with stenting is a minimally invasive endovascular procedure associated with a low risk of complications (12.5%) and a high technical success rate (100%).

2. Performing this procedure in patients with clinically significant graft artery stenosis resulted in a regression of the main symptoms and provided a statistically significant improvement in graft function (p=0.019) in the majority of patients with clinically significant graft artery stenosis.

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