CLINICAL STUDY

Treatment of In-Stent Restenosis in Patients with Renal Artery Stenosis

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ABSTRACT

Purpose: To determine clinical outcomes of patients treated for renal artery in-stent restenosis (ISR) with atherosclerotic renal artery stenosis.

Materials and Methods: A retrospective review was performed of the clinical data of all patients who underwent renal artery stent placement for atherosclerotic renal artery stenosis from 1996 to 2009. Medical records of patients were reviewed for relevant clinical history, including blood pressure, antihypertensive medications, and renal function data before and after an intervention. In 1,052 patients, 1,090 renal artery stent placements were performed. Of these, 101 stents in 79 patients developed ISR, which was treated with either percutaneous transluminal angioplasty (PTA) or repeat stent placement. Procedural details, including modality of intervention, stent diameter, and time to restenosis, were recorded. Hypertensive agent and use of statins were recorded. Univariate analysis was performed to identify risk factors associated with restenosis after treatment of ISR.

Results: Patients treated with repeat stent placement were 6.89 times more likely to lose patency after treatment than patients treated with PTA ($P < .01$). No additional clinical or procedural factor, including smoking history; presence of cardiac, renal, or metabolic disease; use of statin at time of ISR treatment; or diameter of treatment (stent or PTA), had a significant association with duration of stent or angioplasty patency.

Conclusions: Treatment of renal artery ISR with PTA among patients with atherosclerotic renal artery stenosis has a lower rate of subsequent ISR compared with repeat stent placement.

ABBREVIATIONS

BMS = bare metal stent, DES = drug-eluting stent, EVBT = endovascular brachytherapy, ISR = in-stent restenosis, RAS = renal artery stenosis, SBP = systolic blood pressure, SES = sirolimus-eluting stent

Atherosclerotic renal artery stenosis (RAS) is one of the most common causes of secondary hypertension in adults and is an important cause of renal insufficiency (1,2). Treatment options for RAS include medical therapy, surgical reconstruction, and percutaneous revascularization. Stent placement is the preferred method of percutaneous intervention for atherosclerotic RAS (3).

There has been debate over the benefit of percutaneous revascularization for RAS since the Angioplasty and STent for Renal Artery Lesions (ASTRAL) and Cardiovascular Outcomes in Renal Atherosclerotic Lesions (CORAL) trials (4,5). Neither of these randomized prospective studies demonstrated significant benefit when renal artery stent placement was added to medical therapy for RAS. Several limitations have been noted in each of these trials, particularly in terms of their patient enrollment (6–8). Despite the controversy, percutaneous renal artery stent placement should be considered for RAS in cases of unstable angina, pulmonary edema, abrupt congestive heart failure, deteriorating renal function, and hemodynamically significant RAS (9). In these circumstances, renal artery stent placement has been shown to improve hypertension and has a low periprocedural complication rate (10–12).

Major complications or setbacks related to stent placement include artery rupture, dissection, and in-stent restenosis (ISR). Several previously identified risk factors

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of ISR include smaller vessel diameter, prior treatment of ISR, stent type, and cigarette smoking (13). Understanding predictors and outcomes of ISR treatment is important when selecting the appropriate modality for revascularization. In this study, the clinical outcomes of ISR treatment in patients who initially received stents for atherosclerotic RAS were evaluated, including potential risk factors for additional restenosis events.

MATERIALS AND METHODS

Patient Population

Institutional review board approval was obtained for this retrospective, longitudinal follow-up study. The clinical data of all patients who underwent a procedure for renal artery stent insertion for atherosclerotic RAS between 1996 and 2009 were reviewed for development of restenosis with follow-up ending on December 20, 2015. After intervention, the medical record for each patient was reviewed up to the most recent follow-up visit for clinical history, including blood pressure, antihypertensive medications, use of statins, diabetes, vascular disease, dyslipidemia, smoking history, and renal function before and after the intervention. Procedural details, including modality of intervention, stent diameter, and time to restenosis, were recorded.

During the study period, 1,090 renal artery stents were placed in 1,052 patients. Average patient age was 73.6 years ± 8.3. In 79 patients, 101 stents developed ISR, and the patients underwent either repeat stent placement or percutaneous transluminal angioplasty (PTA). Repeat stent placement was performed with either a balloon-expandable bare metal stent (BMS) or a drug-eluting stent (DES). All 101 stents used in the index procedure were BMSs.

Diagnosis of ISR after the index procedure was made with duplex ultrasound (91%), computed tomography angiography (1%), or conventional angiography (8%). ISR was defined as peak systolic velocity of > 300 cm/s or renal-to-aortic ratio > 3.5 on duplex ultrasound or luminal stenosis > 50% on computed tomography angiography or conventional angiography. All cases of significant ISR were treated with a repeat revascularization procedure. All such cases were diagnosed with duplex ultrasound using the same criteria used to diagnose the initial in-stent lesions. Baseline characteristics of patients are summarized in Table 1.

PTA or Stent Placement

Three board-certified interventional radiologists (S.M., M.A.M., H.B.) performed renal artery PTA and/or stent placement. After initial treatment with PTA, if the patient did not have residual stenosis of > 30% on a follow-up angiogram or a mean pressure gradient of < 10 mm Hg measured simultaneously or pullback gradient, the patient received no further treatment. If there was an unsatisfactory PTA result, a bare metal balloon expandable stent such as a Herculink (Abbott Vascular, Abbott Park, Illinois) was used. In a small group of patients, a DES was used.

Blood pressure, creatinine, antihypertensives, and statin medications were documented before and after the procedure. Blood pressure medications were maintained until the day of the procedure. Stent and PTA diameters were recorded.

Measured Outcomes

The primary outcome was the need for reintervention for recurrent ISR. The duration of patency for the intervention was defined as the time between the first

Table 1. Patient Characteristics

Characteristic	PTA (n = 62)	BMS (n = 33)	DES (n = 6)	Total (N = 101)	*P*
Sex, no. (%)					
Female	30 (48.4)	21 (63.6)	3 (50.0)	54 (53.5)	.383
Male	32 (51.6)	12 (36.4)	3 (50.0)	47 (46.5)	
Age, y, mean (SD)	71.0 (8.3)	66.6 (8.3)	73.6 (8.3)	69.7 (8.5)	.029
Bilateral RAS, no. (%)	33 (56.9)	18 (62.1)	3 (60.0)	54 (58.7)	.935
GFR category, no. (%) (mL/min/1.73 m^2)					
GFR 1–3a (≥45)	25 (40.3)	15 (45.5)	1 (16.7)	41 (40.6)	.476
GFR 3b–4 (15–44)	37 (59.7)	18 (54.5)	5 (83.3)	60 (59.4)	
Smoking status, no. (%)					
Former	49 (84.5)	25 (78.1)	4 (66.7)	78 (81.3)	.151
Current	9 (15.5)	6 (18.8)	1 (16.7)	16 (16.7)	
Diabetes, no. (%)	26 (41.9)	9 (27.3)	2 (33.3)	37 (36.6)	.401
Carotid artery disease, no. (%)	36 (58.1)	15 (45.5)	3 (50.0)	54 (53.5)	.510
Coronary artery disease, no. (%)	38 (61.3)	18 (54.5)	4 (66.7)	60 (59.4)	.797
Peripheral artery disease, no. (%)	50 (82.0)	25 (75.8)	5 (83.3)	80 (80.0)	.189
Hyperlipidemia, no. (%)	54 (87.1)	27 (84.4)	5 (83.3)	86 (86.0)	.901
Blood pressure medications, mean (SD)	3.0 (1.1)	2.6 (1.3)	3.3 (1.0)	2.9 (1.2)	.145

BMS = bare metal stent; DES = drug-eluting stent; GFR = glomerular filtration rate; RAS = renal artery stenosis.