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ORIGINAL ARTICLE

Balloon Angioplasty and Stent Placement for Atherosclerotic Renal Artery Stenosis: a Retrospective Efficacy Study

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ABSTRACT

Objective: *To assess the effectiveness of angioplasty and/or stenting of atherosclerotic renal artery stenosis on renovascular hypertension and renal function.*

Patients and Methods: *Between March 2000 and June 2002, seventeen consecutive patients with atherosclerotic renal artery stenosis were referred for renal arteriograms and subsequently underwent balloon angioplasty and/or stenting. Twenty one renal arteries were treated. Eleven patients (64.7%) had both renovascular hypertension and deranged renal function. Four patients (23.5%) were referred for poor hypertension control alone, and 2 patients had impaired renal function alone. Balloon angioplasty was performed first in every case. If repeat angioplasty was unsuccessful, i.e. significant (>60%) residual stenosis and/or the transtenotic pressure gradient was >10 mm Hg, stent placement would be done at the same time. Blood pressure, renal function, and antihypertensive medications were documented during regular follow up before and after the procedure.*

Results: *Four renal arteries (in 4 patients) were adequately treated with angioplasty without stenting. Seventeen renal arteries (in 13 patients) were treated by angioplasty plus stenting. Blood pressure taken 1 month before and 3 to 6 months after the procedure were compared. Nine patients with hypertension (60%) showed improvement in blood pressure. The other 6 patients (40%) showed no significant change. Of the 13 patients with impaired renal function, 2 (15.3%) showed improvement in renal function, 10 (76.9%) showed no change in renal function, while 1 (13%) had worsening.*

Conclusions: *Endovascular intervention is highly effective and safe for controlling hypertension due to renal artery stenosis secondary to atherosclerosis. This approach may also be of value for preventing further impairment of renal function.*

Key Words: *Atherosclerosis, Balloon angioplasty, Renal artery stenosis, Stent*

INTRODUCTION

Atherosclerotic renal artery stenosis is associated with hypertension and progressive loss of renal function. Despite antihypertensive therapy, atherosclerotic stenosis tends to progress, leading to renal ischaemia and loss of renal mass.[1] Restoration of vessel patency reduces the need for antihypertensive medication[2,3] and may slow progression of renal failure.[3-5] This report is of experience in a local centre.

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PATIENTS AND METHODS

Thirty two patients were referred for renal angiograms, of whom 17 (53%) needed intervention. All 17 patients (11 men and 6 women; mean age, 63.4 years; range, 34 to 76 years) had renal angioplasty ± stenting performed for symptomatic renal artery stenosis between March 2000 and June 2002. The study comprised all consecutive patients having renal angioplasty/stenting performed for atherosclerotic renal artery stenosis during this period. Each patient underwent preoperative renal artery duplex scanning, angiography, or both. A total of 21 renal arteries were treated. Two patients (2 renal arteries) had previously had angioplasties performed and had restenosis. Both patients underwent percutaneous transluminal renal artery stenting. Four patients (23.5%) were referred for poor hypertension control, 2 patients

(11.7%) had impaired renal function (serum creatinine level >130 μmol/L), and 11 patients (64.7%) were referred for both hypertension and poor renal function.

Angiographic and Procedural Protocol

A standard retrograde femoral puncture was performed with patients under local anaesthesia, and a diagnostic catheter was advanced to just proximal to the ostium of the stenotic renal artery to obtain a multiplane (i.e. anteroposterior, right anterior oblique, and left anterior oblique) pre-interventional angiogram to define the anatomy of the renal arteries. Angiograms were performed in the bilateral renal arteries. The specific angiographic criteria for enrolment in the study included at least 60% stenosis by comparing the most stenotic segment with the adjacent distal 'normal segment'. There were 13 unilateral and 4 bilateral renal arterial stenoses.

Ostial lesions were defined as stenoses located within 5 mm of the aortic lumen and caused by atherosclerotic disease of the aorta. Pre- and post-interventional pressure measurements were obtained before the intervention when the relevance of a stenosis was in question. Pressure measurements were not performed in instances of critical stenosis (90% stenosis by Doppler ultrasound [US] or renal angiography). The pressure gradient across the stenosis was measured in 9 stenotic arteries. The range of pressure gradient measured approximately 10.0 to 21.0 mm Hg with a mean of 14.5 mm Hg.

The renal arterial orifice was catheterised using a preshaped 5 French catheter, mostly cobra or sidewinder (Figure 1a). Routinely, a soft 0.035 inch hydrophilic guide wire was advanced across the renal arterial stenosis through the angiographic catheter and placed in a peripheral intrarenal branch. The catheter was then pushed forward over the stenosis, and the soft guide wire was replaced with a rigid 0.018 inch guide wire and 7 French guiding catheter. A balloon dilation catheter was advanced over the wire and across the stenosis. Before percutaneous transluminal renal angioplasty (PTRA) or angioplasty with stent placement (PTAS) the patients were given 2500 to 4000 U of heparin directly through the catheter into the stenotic renal artery. The selected balloon diameter was equal to or slightly larger than the estimated diameter of the normal renal artery.

Transtenotic pressure measurements were used to evaluate the success of the balloon dilatation. Stent insertion was performed when a transtenotic pressure gradient higher than 10 mm Hg and/or an angiographic residual

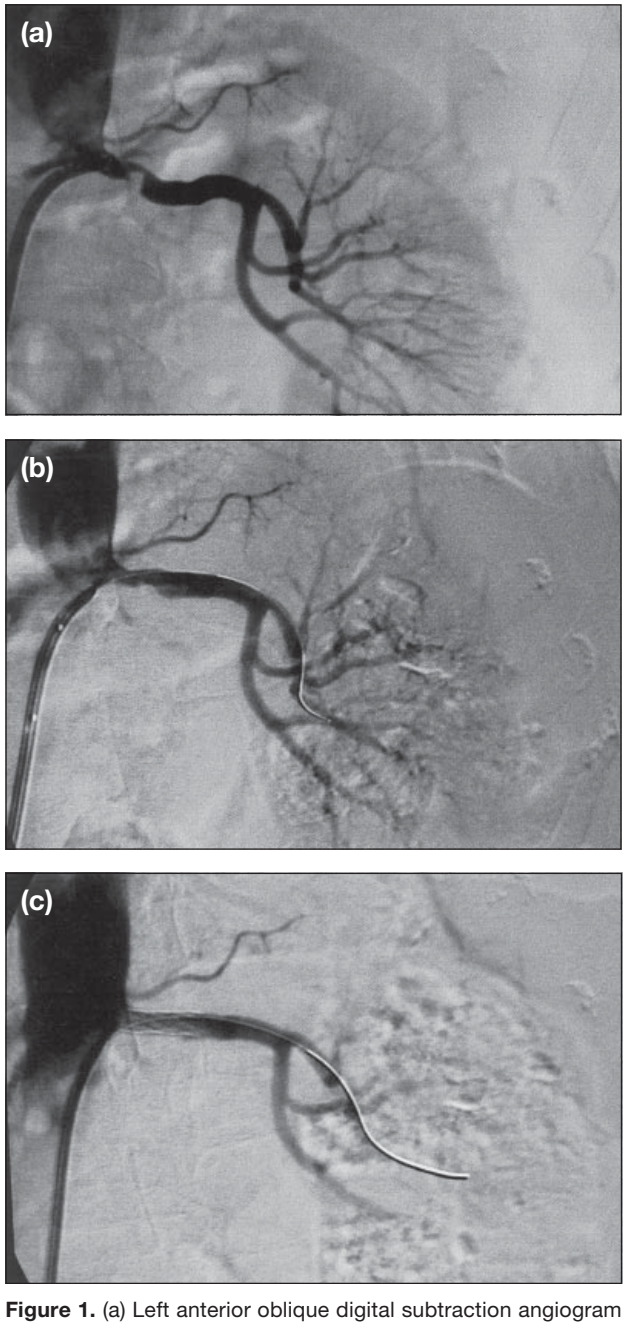

Figure 1. (a) Left anterior oblique digital subtraction angiogram shows proximal left renal artery stenosis (>90% diameter stenosis) in a 38-year-old male patient with hypertension. (b) There is unsatisfactory improvement (>60% residual diameter stenosis) after 3 attempts of angioplasty (percutaneous transluminal renal angioplasty). (c) An excellent morphological result is then achieved by stent placement (percutaneous transluminal renal artery stenting).

stenosis of more than 60% in diameter remained after PTRA after 3 attempts of 10 seconds at the maximum atmospheric pressure allowed (Figure 1b)

Balloon-expandable stents (Genesis Cordis, Miami, USA) were individually fitted. The stent was exactly the same as the calibre of the renal artery (Figure 1c).

For ostial lesions, we attempted to have approximately 1.0 to 1.5 mm of the stent protruding into the aorta to reduce the incidence of recurrence of stenosis.[6]

Complete technical success after PTRA or stent placement was defined as an estimated residual stenosis of less than 30% according to angiographic results and a transtenotic pressure gradient lower than 10 mm Hg. The patients were admitted 1 day before the interventional procedure. Patients with poor renal function (creatinine level >130 μmol/L) or diabetes mellitus received additional fluid to guarantee sufficient hydration.

Continuous monitoring of patients was limited to electrocardiogram, arterial oxygen percent saturation (SaO_2) via oximetry, and blood pressure measurements during the interventional procedure and up to 24 hours after the procedure. Patients were managed with bed rest and continued anticoagulant therapy for 12 hours after the procedure.

Complications were defined as the occurrence of at least 1 of the following: death, myocardial infarction, renal function deterioration of more than 15%, or unexpected start of dialysis within 30 days after endovascular intervention. Other events included haemorrhagic complications, which were defined as bleeding that necessitated transfusion, the need for vascular surgery, or procedural difficulties (i.e. those related to the puncture site, dilation site, or area distal to the dilation site).

Criteria for Evaluating the Effectiveness of the Procedures

A patient was considered cured (diastolic pressure, <90 mm Hg without medication), improved (decrease of 20 mm Hg in systolic/diastolic blood pressure occurring while the patient was taking the same or less medication), unchanged (this did not apply), or worse (systolic blood pressure became uncontrolled or another medication was added).

Patents were evaluated for renal function response after 1 month and between 3 and 6 months if their serum creatinine level was 130 μmol/L or more before the intervention. Responses were classified as improved renal function (decrease in serum creatinine level of 15% or more), no change (serum creatinine ± 14%), or deterioration of renal function (increase in serum creatinine level of 15% or more). Patients' blood pressures were measured 1 month and between 3 and 6 months after the procedures.

RESULTS

Among the 15 patients who had hypertension, blood pressure taken at 1 month before and 3 to 6 months after the procedure were compared. Nine of 15 patients with hypertension (60%) showed improvement in blood pressure. The other 6 patients (40%) showed no significant change. None of the patients showed deterioration in blood pressure measurements (Table 1).

Of the 13 patients with impaired renal function, 2 (15.3%) showed improvement, 10 (76.9%) showed no change, and 1 (13.0%) had worsening renal function (Table 2).

No major complications were encountered during and after the procedures. Post-angioplasty/stenting angiogram did not show any angiographic signs of distal embolisation or intrarenal arterial embolisation. Only 2 patients had 2 small groin haematomas, which healed with conservative management.

DISCUSSION

Renal artery stenosis is an uncommon but curable cause of systemic hypertension. Approximately 4% of hypertensive patients have potentially corrective renovascular hypertension. Renal artery stenosis may also contribute to renal insufficiency, particularly if both renal arteries are involved. The cause of the stenosis is usually atherosclerosis (65%).

Clinical suspicion is paramount in identifying renal artery stenosis because the initial presentation is often subtle and progresses to a further degree of renal failure or hypertensive sequelae.[7] Many series have shown a favourable reduction of antihypertensive methods after the successful resolution of renal artery stenosis.[6,8-12] For example, in Rees' study of 28 patients, 3 were found to be cured of hypertension, 15 had improved, and 10 failed to improve (total benefit, 64%).[6]

Table 1. Change in blood pressure among patients with hypertension following the procedure (n = 15).

Blood pressure response	Cured	Improved	Unchanged	Worse
Number of patients (%)	0 (0)	9 (60)	6 (40)	0 (0)

Table 2. Change in renal function among patients with impaired renal function after the procedure (n = 13).

Change in renal function	Improved	No change	Deteriorated
Number of patients (%)	2 (15.3)	10 (76.9)	1 (7.7)

Significant improvement in creatinine levels was not achieved after successful resolution of the renal artery stenosis. This is in accordance with Blum et al's study, in which the renal function in 20 patients who had mild or severe renal dysfunction before the intervention did not change during follow up.[12] This finding is important, because untreated stenosis may progress in severity, resulting in renal artery occlusion, loss of renal mass, and a subsequent decrease in kidney function.[13] However, Boisclair et al reported improved creatinine levels in 7 of 17 patients (44%) after successful stenting for atherosclerotic renal artery stenosis.[14]

This study may have demonstrated prevention in further renal function impairment. Twelve of 13 patients (92%) who initially had renal function deterioration showed either improvement in renal function or stable renal function. Perhaps future trials will delineate whether one can expect improved postoperative creatinine levels in patients with renal insufficiency.

Complication rates for PTRA/PTAS are less than 10%, and may include exacerbation of the patient's chronic renal insufficiency, which is frequently transient. This complication reflects the increased risk of contrast nephropathy in patients with renal insufficiency. In selected patients, arteriography can be performed using carbon dioxide, to minimise iodinated contrast use and reduce the risk of contrast nephropathy. There were no major complications encountered in this study during or after procedures.

CONCLUSIONS

Endovascular intervention is highly effective and safe for controlling hypertension due to atherosclerotic renal artery stenosis. The procedure may also be of value in preventing further impairment of renal function.

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