ORIGINAL ARTICLE

Endovascular Treatment of Renal Artery Stenoses

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ABSTRACT

Objective: To evaluate the procedure success and effect on hypertension after stenting of incidentally diagnosed atherosclerotic renal artery stenoses.

Study Design: An experimental study.

Place and Duration of Study: A multicentric study was conducted at the Plastic Surgery and General Hospital, National Medical Center and Ziauddin University Hospital, Karachi, Pakistan from January 2009 to March 2013.

Methodology: Hypertension (systolic blood pressure > 160 and diastolic > 90 mmHg with two or more than two medications) with coronary artery disease were initially evaluated for coronary angiography, Renal artery angiography was also endovascular performed and stent was deployed for atherosclerotic renal artery stenosis when found. Blood pressure readings, reduction in need of antihypertensive medication and serum creatinine levels were taken as outcome measures. Patients having renal artery stenoses secondary to connective tissue disorders and fibromuscular dysplasia were excluded.

Results: There were 25 patients, 14 (56%) male and 11 (44%) female, with mean age of 49 ± 6 years. Diabetes mellitus, dyslipidemia and smoking were seen in 11 (44%), 10 (40%) and 4 (16%) patients respectively. Renal insufficiency (serum creatinine > 1.5 mg/dl) was seen in one (04%) patient. Bilateral, and isolated right and left renal artery stenoses was seen in 5 (20%), 9 (36%) and 11(44%) patients respectively. Mean percentage of renal artery stenoses was 89%, ranged from 70% to 99% while ostial lesion was found in 20 (80%) patients. A significant decrease in systolic (168.20 ± 9.987 vs. 140.60 ± 5.649 mmHg, $p < 0.001$) and diastolic blood pressure (88.60 ± 5.50 vs. 77.20 ± 5.017 mmHg, $p < 0.001$) and reduction of medication (2.72 ± 0.458 vs. 1.5 ± 0.510, $p < 0.01$) were noted without a change in renal function ($p= 0.061$) after renal artery stenting.

Conclusion: Endovascular stenting of renal artery stenoses in patients with poorly controlled hypertension is a safe and effective treatment.

Key Words: *Endovascular stenting. Renal artery stenoses. Percutaneous transluminal renal angioplasty (PTRA).*

INTRODUCTION

Renal artery stenoses are clinically important lesions because of their potential to compromise renal function, leading to or exacerbating hypertension. The natural history of renal artery stenoses is a progressive deterioration of renal function.[1] A more liberal approach to Percutaneous Transluminal Renal Angioplasty (PTRA) has been advocated for the treatment of renal artery stenoses.[2] Although there are numerous surgical options available for the treatment of renal artery stenoses, there is an increasing interest in a minimally invasive approach (i.e. PTRA with stent) by both physicians and patients alike.

The first PTRA was reported in 1978 by Grüntzig *et al*.[3] Compared with conventional surgery, PTRA is a simple procedure associated with a low morbidity rate and has been shown to have a high immediate technical success rate;[2,4-6] however, the re-stenoses rate has been unsatisfactory. In a review by Martin *et al*., the incidence of restenoses after a technically successful PTRA was 30%.[5] Furthermore, this same incidence was demonstrated in a prospective trial by Weibull *et al*.[6] High restenoses rates occur after the treatment of atherosclerotic ostial lesions because they in fact represent an extension of severe aortic atheromatous disease. In 1987, Palmaz *et al*. introduced stenting of the renal arteries in animal models.[7] Not long thereafter, the use of stents was reported as an adjunct to PTRA.[8-10] With the increasing involvement of interventional cardiologists in the percutaneous management of peripheral vascular problems, it is necessary to evaluate the efficacy of these interventions.

In this study, the aim was to evaluate the technical outcome and effects on hypertension of stent placement in patients with atherosclerotic renal artery stenoses.

METHODOLOGY

It was an experimental, multi-center study, conducted at the Plastic Surgery and General Hospital, National Medical Center and Ziauddin University Hospital, Karachi, Pakistan from January 2009 to March 2013. A total of 25 patients were included in this study, among whom renal artery stenoses (> 70%) was incidentally

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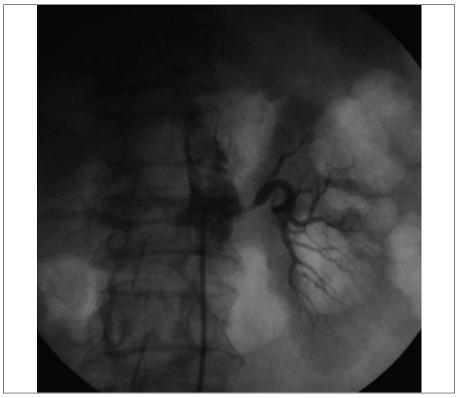

Figure 1: Bilateral renal artery stenosis.

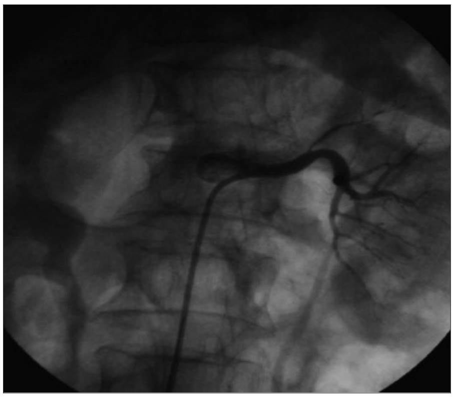

Figure 2: Left renal artery after stenting.

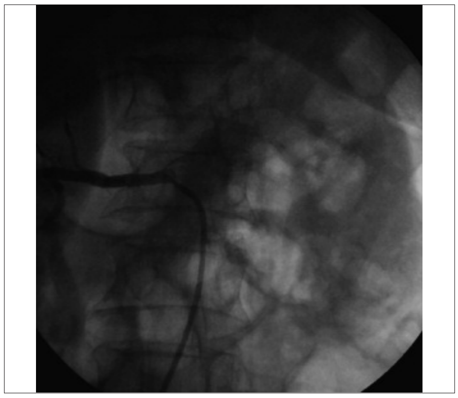

Figure 3: Right renal artery after stenting.

diagnosed in hypertensive patients routinely imaged for renal arteries; underwent coronary angiography for coronary artery diseases. Patients having a connective tissue disorder and fibro-muscular disorder were excluded from study. Hypertension (systolic blood pressure > 160 and diastolic > 90 mmHg with two or more than two medications) and coronary disease was seen in all patients. In this subset of patients, the decision to treat the renal artery lesion was a clinical judgment on the basis of the high degree renal artery stenoses (89 ± 10%) present in the setting of hypertension requiring 2.72 ± 0.458 agents for control. The lesion was considered ostial if it involved the proximal 5 mm of the renal artery. All endovascular procedures were performed in an interventional suite by experienced interventional cardiologist. After gaining percutaneous arterial access, a selective renal arteriogram was performed with nonionic iodinated contrast. The lesion(s) was localized by use of a 6F right Judkin coronary catheter, and a road map image was created. Blood pressure in right arm was taken before and after 24 hours of procedure by auscultatory method. Percent stenoses were determined by qualitative (visual) method. A 6F renal artery guiding catheter was positioned at the renal artery orifice, through which coronary guide wire (cougar Medtronic) was passed. When the decision to place a stent was made, balloon expandable stent were mounted on the delivery system and the stent and guiding catheter were placed across the stenoses. The guiding catheter was then retracted, and the stent was deployed (Figures 1 - 3). Patients were given systemic anticoagulants during the interventions and received 50 - 100 µg aliquots of nitroglycerin directly into the renal artery before each catheter or guide wire exchange as prophylactic treatment against vasospasm. Technical success was defined as safely crossing and dilating the stenosis with no major morbidity, a residual stenosis of less than 10%. Clinical success was achieved if the patient derived benefit from the stenting, manifest as an improvement in blood pressure; a reduction in number of antihypertensive medications; or an improvement or no change in renal function.

SPSS 16 software used for data analyses. Descriptive data were expressed as mean ± SD. Differences between groups were calculated by the paired t-test for continuous variables. Probability values less than 0.05 were considered statistically significant.

RESULTS

A total of 25 patients, 14 (56%) male and 11 (44%) female, their mean age was 49 ± 6 years and ranged from 40 to 72 years were included. Diabetes mellitus, dyslipidemia and smoking was seen in 11 (44%), 10 (40%) and 04 (16%) patients respectively (Table I). Renal insufficiency (serum creatinine > 1.5 mg/dl) was seen in 01 (04%) patient. Bilateral, and isolated right and left renal artery stenoses was seen in 05 (20%), 09 (36%) and 11 (44%) patients respectively. Mean percentage renal artery stenoses was 89%, ranged from 70% to 99% while ostial lesion found in 20 (80%) patients. After renal artery stenting, there was a statistically significant overall improvement in both

Table I: Demographic variables.

Variables	Value
Male / female (no.)	14 / 11
Age (years)	49 ± 6 (Range 40 - 72)
Hypertension	25 (100%)
Coronary artery disease	25 (100%)
Diabetes mellitus	11 (44%)
Dyslipidemia	10 (40%)
Smoking	04 (16%)
Renal insufficiency (serum creatinine > 1.5 mg/dl)	01 (04%)

Table II: Clinical variables before and after renal artery stenting (mean ± SD).

Variable	Before stent (n=25)	After stent (n=25)	p-value
Systolic blood pressure (mmHg)	168.20 ± 9.987	140.60 ± 5.649	< 0.001
Diastolic blood pressure (mmHg)	88.60 ± 5.500	77.20 ± 5.017	< 0.001
Number of antihypertensive medications	2.72 ± 0.458	1.5 ± 0.510	< 0.01
Serum creatinine level (mg/dl)	1.2 ± 0.3	1.2 ± 0.2	0.061

systolic and diastolic arterial pressures and in the reduction of number of antihypertensive medications (Table II). Primary technical success was achieved in 25 (100%) patients. Overall, a significant decrease in systolic (168.20 ± 9.987 vs. 140.60 ± 5.649 mmHg, $p < 0.001$) and diastolic pressures (88.60 ± 5.500 vs. 77.20 ± 5.017 mmHg, $p < 0.001$) and reduction of medication (2.72 ± 0.458 vs. 1.5 ± 0.510, $p < 0.01$) were noted without a change in renal function ($p = 0.061$) after renal artery stenting (Table II).

DISCUSSION

After the first renal artery angioplasty by Grüntzig *et al*. in 1978,[3] catheter-based revascularization has become widely accepted for the treatment of atherosclerotic reno-vascular disease. The morbidity of a major surgical procedure is avoided in a population of patients who are often elderly, have azotemia, and are debilitated because of other manifestations of systemic athero-sclerotic disease. The concomitant use of stents has been claimed to be superior to angioplasty alone in maintaining luminal diameter and decreasing the trans-lesion pressure gradient.[11] Nonetheless, the incidence of re-stenoses is of concern, ranging from 11%,[12] to 44%,[4] at 2 years. Therapeutic goals and result expectations cannot be the same as in patients who are younger, have recent onset of hypertension, and have normal renal function. Open surgical renal revascularization is a proven standard, albeit not one without significant risk, with morbidity and mortality rates ranging from 7% to 44%.[13] Currently, there is a wider variety of stents available for use, although to-date, none have demonstrated superior efficacy. Most renal artery lesions meeting the indications for stenting in this study was ostial (80%) because of the high prevalence of systemic atherosclerotic disease. With stenting of mainly ostial renal artery lesions a higher procedural success rate (100%) was achieved. Critical ostial lesions have presented a challenge to the interventionalist because of the recoil and resistance of the aortic plaque. Stents were positioned to protrude 1 - 1.5 mm into the aortic lumen. Thus, the technical success rate for procedures was high. Patients with asymptomatic renal artery stenoses would not have otherwise been detected, unless the stenosis was discovered as an incidental finding during angiography performed for other reasons. The pre-procedural and post-procedural blood pressures were monitored for changes, as were the number of medications the patient was taking for control, with statistically significant reductions seen in both. Although other investigators have reported a similar clinical benefit after stenting[14,6,12] as in these patients. It is theoretically possible that clinical benefit occurred in spite of restenosis.[2] In a similar study, White *et al*. reported 6-month outcomes in a cohort of 100 patients with stents and observed continued lowering of the BP.[14] Blum *et al*. reported that 16% of their patients had long-term (27-month) normalization of blood pressure.[15] Other studies have observed higher rates of unchanged 36% - 67%) or improved (29% - 36%) renal function (defined as a 20% improvement in serum creatinine value after stent placement).[10,12,13,17] Because the natural history of atherosclerotic renal vascular disease is progression to occlusion with imminent kidney failure, a slowing of the rate of deterioration and preservation of the remaining renal function are realistic goals of renal revascularization in patients with this disease.[18] As previously stated, it is unclear whether a lack of change in serum creatinine level truly represents stabilization of renal function or a retardation of the rate of progression.[19] Indeed, Harden *et al*. demonstrated that in patients with two functioning kidneys and unilateral renal artery stenosis, the rate of decline in renal function was decreased after stent deployment.[16] The work of Harden *et al*., supports those who argue that stabilization of renal function or delay in the progression of functional impairment is indicative of successful treatment in the azotemic population.[11] Additionally, improvement of BP control and lowering the number of medications needed may lead to an improvement in renal function. A high procedural success rate (97.6% vs. 100% in this study) was combined with an improvement in hypertension without any significant change in serum creatinine levels.[7,18,20]

This study demonstrated that experienced inter-ventionalist cardiologists can successfully perform the stenting of renal artery stenoses. Although morbidity, and even death can occur, percutaneous methods can play an important role in hypertension control in this patient population. Many patients, such as the ones presented in this study, may not tolerate a major open surgical revascularization. In patients who undergo intervention for the control of hypertension, results are encouraging. Indeed, the patients with extreme renal excretory dysfunction did not benefit from endovascular treatment, emphasizing the need for a high clinical suspicion of renal artery stenoses and earlier diagnosis.

CONCLUSION

This study results showed that the endovascular treatment of renal arteries stenoses was safe and effective in patients with poorly controlled hypertension.

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