Percutaneous Transluminal Renal Angioplasty in Patients with Renovascular Hypertension: Long-Term Results

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This study evaluated the long-term effects of percutaneous transluminal renal angioplasty (PTRA) on blood pressure and renal function in patients with renovascular hypertension. Seventy-eight patients with hypertension and unilateral or bilateral stenoses of the renal arteries (16 with fibromuscular dysplasia and 62 with atherosclerosis) were studied. All patients with fibromuscular dysplasia (group A) had normal renal function, while 27 of the 62 patients with atherosclerosis (group B) presented with various degrees of renal failure. PTRA was technically successful in 87.5% patients of group A. The overall technical success rate (complete plus partial) was 72.3% (55/76 renal arteries) in group B. Mean follow-up (range) in months was 42 (12-108) for group A and 39 (13-106) for group B. After successful PTRA, the overall benefit rate (cure plus improved) for hypertension was 100% in group A; 10 of 14 patients were cured and 4 of 14 were improved. In group B, the overall benefit rate was 70.8%; 9 of 48 were cured and 25 of 48 were improved. PTRA was technically successful in 18 of 27 patients with renal failure. Renal function improved in 4 of 18 patients, remained stable in 9 of 18, and deteriorated in 5 of 18 patients. The above results suggest that PTRA is an effective method for the long-term management of patients with renovascular hypertension, although the results were less favorable in the presence of bilateral renal artery stenoses: in addition to improved control of blood pressure, PTRA might improve renal function or delay its progressive deterioration. (Hypertens Res 1995; 18: 27-31)

Key Words: percutaneous transluminal renal angioplasty (PTRA), renovascular hypertension, blood pressure, renal function

The prevalence of renovascular hypertension varies depending on the characteristics of the hypertensive population being studied. In nonselected patient populations the prevalence is less than 1%, while among patients referred for diagnostic studies it is between 2% and 4% (1). However, among patients with accelerated or malignant hypertension the prevalence of renovascular hypertension is about 30%, and rises to about 40% when renal insufficiency is present (2, 3). Currently available potent and well tolerated antihypertensive drugs have greatly improved the medical management of patients with renovascular hypertension. Despite adequate control of blood pressure, however, a progressive deterioration of renal function may be observed.

Reconstructive surgery has been demonstrated to be effective for the improvement of blood pressure and the recovery or the stabilization of renal function, but the associated morbidity and mortality continue to be substantial, especially in patients with extensive atherosclerotic vascular disease (4, 5). Following the first report of successful percutaneous transluminal renal angioplasty (PTRA) in a patient with renal artery stenosis (6), this technique has since been established as the treatment of choice for revascularization of the ischemic kidney in most patients with renovascular hypertension. We herein report the technical and long-term functional outcomes of PTRA in 78 consecutive hypertensive patients with fibromuscular or atherosclerotic renovascular disease.

Materials and Methods

1. Patient Selection

During the last 8 years we have attempted, at the Ippokration Hospital of Thessaloniki, percutaneous transluminal renal angioplasty in 78 patients with hypertension and unilateral or bilateral stenoses of the renal arteries. After confirming initial positive findings by either intravenous rapid-sequence pyelographic examination or radioisotopic studies with 99ᵐTc-DTPA, all patients underwent aortography and, when needed, renal arteriography. Vascular...
lesions were considered clinically important when associated with stenosis of more than 75%. The patients were classified into two groups according to their angiographic characteristics: the first group (group A) included 16 patients (7 males, mean age 31 years, range 9-49; 9 females, mean age 28 years, range 22-36) with fibromuscular dysplasia, and the second group (group B) included 62 patients (38 males, mean age 65 years, range 28-75; 24 females, mean age 64 years, range 45-72) with atherosclerosis. All patients in group A had unilateral stenosis. Among the 62 patients in group B, 41 had unilateral stenosis, 14 bilateral stenoses, and 7 solitary stenosis (i.e., stenosis of a renal artery supplying a solitary functioning kidney).

In group A, all patients had normal renal function (serum creatinine = 1.05 ± 0.02 mg/dl; renal insufficiency is defined by a serum creatinine level ≥1.5 mg/dl). In the group B, 27 of the 62 patients presented with various degrees of renal failure (serum creatinine = 2.14 ± 0.02 mg/dl); 12 of 41 belonged in the unilateral, 10 of 14 in the bilateral, and 5 of 7 in the solitary subgroup. The remaining 35 of the 62 patients in group B had normal renal function (serum creatinine = 1.08 ± 0.01 mg/dl).

2. Criteria for Outcome of PTRA
The criteria for the technical outcome of PTRA have been described previously and are based on the findings of arteriographic examination performed immediately after the procedure (7). For unilateral stenosis or stenosis in a solitary functioning kidney, complete success was defined as residual stenosis of 50% or less; partial success as residual stenosis of more than 50%, but less than or equal to 70%; and failure as residual stenosis of more than 70% or inability to place the angioplasty catheter in the stenotic lesion. For bilateral stenoses, complete success was defined as residual stenosis of 50% or less in all lesions; partial success as residual stenosis of 70% or less on at least one side; and failure as bilateral residual stenoses of more than 70% or inability to place the angioplasty catheter in the stenotic lesions.

The response of blood pressure was assessed by the criteria used in the Cooperative Study of Renovascular Hypertension (8). Blood pressure measurements at the latest follow-up examination were used to determine outcome. Cure was defined as a diastolic pressure of 90 mmHg or less without antihypertensive therapy. Improvement was defined as a decrease of 15% or more in diastolic pressure while the patient received the same or fewer antihypertensive drugs as before PTRA. In all other cases, blood pressure responses were considered as failures.

3. Statistical Analysis
For statistical analysis, Student’s t-test was employed, and a p value of < 0.05 was considered to indicate statistical significance. Data are presented as mean ± SEM.

Results

1. Technical Outcome of PTRA
Percutaneous transluminal renal angioplasty was technically successful in 14 of the 16 patients in group A and unsuccessful in the other 2 patients. In group B, PTRA was performed in 62 patients (76 renal arteries). The overall technical success (complete plus partial success) was 72.4% (55/76 renal arteries). The overall technical success was 87.8%, 50.0% and 71.4% for the unilateral, bilateral and solitary subgroups, respectively.

2. Blood Pressure Outcome after Technically Successful PTRA
Mean duration of follow-up (range) in months was 42 (12-108) in group A, and 41 (13-106), 48 (15-96) and 18 (16-72) in the unilateral, bilateral and solitary subgroups of group B, respectively. The overall benefit rate (cure plus improved) for the patients with fibromuscular dysplasia was 100%; 10 of 14 were cured and 4 of 14 were improved. In group B, the overall benefit rate for the patients with unilateral stenosis was 72.2%; 8 of 36 patients were cured and 18 of 36 were improved. In the patients with bilateral stenoses, the overall benefit rate was 57.1%; 1 of 7 patients was cured and 3 of 7 were improved. In the patients with a solitary functioning kidney, 4 of 5 patients were improved (Tables 1 and 2).

3. Renal Function Outcome after Technically Successful PTRA
Renal insufficiency was present in 27 of the 62 patients with atherosclerotic renal artery stenosis (serum creatinine = 2.14 ± 0.02 mg/dl). All patients with fibromuscular dysplasia had normal renal function. PTRA was technically successful in 18 of 27 patients. Among the 9 patients in the unilateral subgroup, renal function improved in 1 patient, remained unchanged in 7 patients, and further deteriorated in 1 patient. Among the 6 patients in the bilateral subgroup, renal function improved in 1 patient, remained unchanged in 2 patients, and further deteriorated in 3 patients. Among the 3 patients in the solitary subgroup, renal function improved in 2 patients, and further deteriorated in 1 patient (Tables 3 and 4). The changes in serum electrolytes were not significant.

Complications

There were no deaths within 30 days after PTRA. Complications occurred in 4 of the 78 patients (5.1%). One major complication, rupture of the renal artery, occurred in a 26-year-old woman with fibromuscular dysplasia and required nephrectomy of the ipsilateral kidney. Minor complications included transient, mild acute renal failure, not requiring dialysis, in two patients. Thrombotic occlusion of a femoral artery was surgically corrected in a 72-year-old man. All the above patients fully recovered clinically.
Discussion

Percutaneous transluminal renal angioplasty was performed in 78 consecutive patients with hypertension and angiographic characteristics of fibromuscular or atherosclerotic renovascular disease. The technical outcome and the blood pressure outcome of PTRA in the present study were comparable to those reported in large groups of patients from other centers. In renovascular hypertension associated with fibromuscular dysplasia, the overall technical success rate has been reported to be about 90%, with approximately 60% of patients meeting the criteria for cure of hypertension (7, 9-15). Ramsay and Waller (16) reviewed 10 large series in order to evaluate the safety and efficacy of PTRA in the treatment of renovascular hypertension. The inclusion criteria varied considerably between studies, and in eight series the mean duration of follow-up after PTRA was reported to vary from 11 to 26 months. In the group of 175 patients with fibromuscular dysplasia, the overall benefit rate (cure plus improved) was 92%; 50% were cured and 42% were improved. In group A, our technical success rate was 87.5%. After successful PTRA, the overall benefit rate for the patients with fibromuscular dysplasia was 100%; 71.4% were cured and 28.6% were improved.

In renovascular hypertension associated with atherosclerosis, the overall technical success rate in patients with unilateral stenosis also approximates 90%, while in patients with bilateral stenoses it is about 67% (7, 13, 18-21). In our study, the respec-

### Table 1. Blood Pressure Outcome after a Technically Successful PTRA

<table>
<thead>
<tr>
<th>Type of stenosis</th>
<th>Cure</th>
<th>Improvement</th>
<th>Failure</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibromuscular dysplasia (n=14)</td>
<td>10 (71.4)</td>
<td>4 (28.6)</td>
<td>—</td>
</tr>
<tr>
<td>Atherosclerosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral (n=36)</td>
<td>8 (22.2)</td>
<td>18 (50.0)</td>
<td>10 (27.8)</td>
</tr>
<tr>
<td>Bilateral (n=7)</td>
<td>1 (14.4)</td>
<td>3 (42.8)</td>
<td>3 (42.8)</td>
</tr>
<tr>
<td>Solitary kidney (n=5)</td>
<td>—</td>
<td>4 (80.0)</td>
<td>1 (20.0)</td>
</tr>
</tbody>
</table>

Results are numbers (percentages) of patients.

### Table 2. Blood Pressure Outcome after a Technically Successful PTRA in Patients with Renovascular Hypertension

<table>
<thead>
<tr>
<th>Type of stenosis</th>
<th>Blood pressure baseline (mmHg)</th>
<th>Blood pressure latest (mmHg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fibromuscular dysplasia (n=14)</td>
<td>204±7.8/122±4.2</td>
<td>138±6.9/88±3.9*</td>
</tr>
<tr>
<td>Atherosclerosis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral (n=36)</td>
<td>198±6.7/118±5.1</td>
<td>148±6.4/94±4.1*</td>
</tr>
<tr>
<td>Bilateral (n=7)</td>
<td>206±8.1/109±4.8</td>
<td>178±8.6/98±5.3**</td>
</tr>
<tr>
<td>Solitary kidney (n=5)</td>
<td>195±7.9/114±6.7</td>
<td>151±5.2/92±4.2*</td>
</tr>
</tbody>
</table>

Data presented as mean ±SEM. *p<0.01, **p<0.05, NS=p=NS.

### Table 3. Renal Function Outcome after a Technically Successful PTRA

<table>
<thead>
<tr>
<th>Type of stenosis</th>
<th>Improvement</th>
<th>Stabilization</th>
<th>Deterioration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherosclerosis</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral (n=9)</td>
<td>1 (11.1)</td>
<td>7 (77.7)</td>
<td>1 (11.1)</td>
</tr>
<tr>
<td>Bilateral (n=6)</td>
<td>1 (16.6)</td>
<td>2 (33.3)</td>
<td>3 (50.0)</td>
</tr>
<tr>
<td>Solitary kidney (n=3)</td>
<td>2 (66.6)</td>
<td></td>
<td>1 (33.3)</td>
</tr>
</tbody>
</table>

Results are numbers (percentages) of patients.

### Table 4. Renal Function Outcome after a Technically Successful PTRA in Patients with Renal Insufficiency

<table>
<thead>
<tr>
<th>Type of stenosis</th>
<th>Urea baseline (mg/dl)</th>
<th>Urea latest (mg/dl)</th>
<th>Creatinine baseline (mg/dl)</th>
<th>Creatinine latest (mg/dl)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Atherosclerosis</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral (n=9)</td>
<td>62.4±0.05</td>
<td>59.7±0.04*</td>
<td>1.7±0.08</td>
<td>1.8±0.06*</td>
</tr>
<tr>
<td>Bilateral (n=6)</td>
<td>88.3±0.04</td>
<td>86.4±0.08*</td>
<td>2.9±0.06</td>
<td>3.5±0.08†</td>
</tr>
<tr>
<td>Solitary kidney (n=3)</td>
<td>82.6±0.05</td>
<td>74.3±0.07*</td>
<td>2.6±0.06</td>
<td>2.4±0.06*</td>
</tr>
</tbody>
</table>

Data presented as mean ±SEM. *p=NS, †p<0.05.
tive success rates were 87.8%, 50.0% and 71.4% in the unilateral, bilateral and solitary subgroups, respectively. In the review of Ramsay and Waller (16), among 391 patients with atherosclerosis, 19% were cured, 52% were improved, and in 30% the blood pressure remained unchanged. In the study of Canzanello et al. (17), the mean technical success rates among 101 patients with atherosclerotic renovascular hypertension were 76%, 74% and 68% in the unilateral, bilateral and solitary subgroups, respectively. In our study, in group B the overall benefit rate for the patients with unilateral stenosis was 72.2%; 22.2% were cured and 50.0% were improved. In the patients with bilateral stenoses the overall benefit rate was 57.1%; 14.4% were cured and 42.8% were improved. In the patients with a solitary functioning kidney, 80% patients were improved.

The natural history of renovascular hypertension is dependent on the progression of the stenosis itself, the development of a stenosis in a previously normal contralateral renal artery, and on the consequences of the elevated systemic blood pressure on both kidneys. Despite adequate control of blood pressure, the progressive nature of stenotic lesions have been documented by several studies (22-28). The severity of progression is clearly dependent on the type of underlying disease. In patients with fibromuscular dysplasia, progression of the lesion was noted at a rate between 16-38% (25-27), while total occlusion of the renal artery occurred rarely (28). In the case of atherosclerotic stenosis, on the other hand, lesion progression has been reported in 36-63% of the patients (23-25, 27); total vessel occlusion was also observed relatively often (10-16%) during follow-up ranging from 6 months to more than 7 years.

The exact prevalence of renovascular hypertension as a cause of end-stage renal disease is not known and it is presumably underestimated at present (29-31). The European Dialysis and Transplant Registry estimated this percentage to be 7.8% of the total registered dialysis population in 1982 and 9.8% in 1987 (32). Presently, however no significant changes in the above rates of progression or occlusion have been noted, despite improvements in antihypertensive drug treatment since the earlier studies. These data imply that in patients with renovascular hypertension a more aggressive approach is needed to prevent deterioration of renal function, particularly in the presence of atherosclerotic lesions.

In this study all patients with fibromuscular dysplasia had normal renal function, while of the 62 patients with atherosclerotic renal artery stenosis, 27 (43.5%) appeared to have various degrees of renal failure. PTRA was technically successful in 18 of 27 (64.2%) patients; technical success rates were 75%, 60% and 50% in the unilateral, bilateral and solitary subgroups, respectively.

The beneficial effects of PTRA on renal function are different in clinically distinct groups of unilateral stenosis, bilateral stenoses and stenosis in a solitary functioning kidney. Revascularization in patients with unilateral stenosis and a normal renal artery contralaterally generally does not result in marked improvement of renal function (33-35). Deterioration of renal function is due to the effect of long-standing hypertension on both kidneys. In our study, after successful PTRA, the renal function improved only in 1 of 9 patients, while that in 7 of 9 patients did not change. In patients with bilateral stenoses, the beneficial effects of revascularization are present especially after bilateral repair (36), although the Cleveland group reported that their results were not very different from those in patients with unilateral revascularization of only the more stenotic artery (37). In bilateral disease, both kidneys, in fact, are relatively protected from the unfavourable effects of high systemic blood pressure (3). In this study, after bilateral PTRA, 1 of 6 patients improved and in 2 of 6 patients the renal function remained unchanged. In patients with stenosis in a solitary kidney, renal function can be improved or stabilized in a substantial percentage, the exceptions being when renal function is severely impaired due to far advanced structural damage within the kidney. In our solitary kidney subgroup, 2 of 3 patients showed an improvement in their renal function. Encouraging results in the preservation of renal function have been reported by other centers (3, 17, 38-40).

We conclude that revascularization by percutaneous transluminal renal angioplasty is effective in both the long-term management of hypertension and the preservation of renal function in most patients with renovascular hypertension. PTRA might be considered the procedure of choice in the management of patients with fibromuscular dysplasia. In patients with atherosclerotic renovascular disease, the results are better in the subgroup of unilateral renal artery stenosis than in the subgroup of bilateral renal artery stenoses. In patients with refractory hypertension and associated renal insufficiency, careful investigation is necessary to detect possible renovascular causes. In these patients, PTRA might contribute to adequate blood pressure control and it might improve or delay the progressive deterioration of their renal function.

References


