PCI for Renal Artery stenosis
Why should we treat Renal Artery Stenosis?
**Natural History of RAS**

**RAS is progressive disease**

<table>
<thead>
<tr>
<th>Study</th>
<th>Follow-up (months)</th>
<th>Pts</th>
<th>Progression N (%)</th>
<th>Total occlusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wollenweber</td>
<td>12 ~ 88</td>
<td>30</td>
<td>21 (70 %)</td>
<td></td>
</tr>
<tr>
<td>Meaney</td>
<td>6 ~ 120</td>
<td>39</td>
<td>14 (36)</td>
<td>3 (8%)</td>
</tr>
<tr>
<td>Dean</td>
<td>6 ~ 102</td>
<td>35</td>
<td>10 (29)</td>
<td>4 (11)</td>
</tr>
<tr>
<td>Schreiber</td>
<td>12 ~ 60</td>
<td>85</td>
<td>37 (44)</td>
<td>14 (16)</td>
</tr>
<tr>
<td>Tollefson</td>
<td>15 ~ 180</td>
<td>48</td>
<td>34 (71)</td>
<td>7 (15)</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>6 ~ 180</strong></td>
<td><strong>237</strong></td>
<td><strong>116 (49)</strong></td>
<td><strong>28 (14)</strong></td>
</tr>
</tbody>
</table>

**Renal Artery Stenosis**

**Clinical Consequences**

**Cardiovascular**
- Angina pectoris
- “Flash” pulmonary edema
- Myocardial infarction
- Left ventricular hypertropy
- Stroke
- Aortic dissection

**Renal**
- Chronic renal insufficiency
- End-stage renal disease
Renal Artery Stenosis

4 year adjusted survival

% 100
80
60
40
20
0

89%
57%

No RAS  RAS

Independent Predictor of Mortality

Conlon et al. Kidney Int 2001;60(4):1490-7
Severity of RAS vs Survival

Severity of Stenosis

4 year adjusted survival

%  
70%  68%  48%

50%  75%  > 95%

Conlon et al. Kidney Int 2001;60(4):1490-7
Why should we treat Renal Artery Stenosis?

**Improve Morbidity / Mortality**

- Salvage Renal Function
- Adequate BP Control
Medical Treatment

Aggressive pharmacologic therapy is sufficient for adequate BP control and maintenance of renal function?
Outcome of RAS

Medical treatment

69 pts with RAS > 70%, Follow-up 36 Mo

• Mean Cr : 1.4 → 2.0 mg/dl (p<0.05)
• SBP : 157 mmHg → 155 mmHg (p=NS)
• 10 % progressed to ESRD
  10 % progressed to renal intervention
  29 % mortality

Outcome of RAS
Managed without Revascularization

Renal Insufficiency can be progressive despite aggressive BP control
Renal Artery Stenosis

Rationale for Invasive Treatment

- Progressive disease
- Cause of hypertension and decline in renal function
- Associated with increased mortality
- Limited benefit of aggressive medical therapy
Renal Artery stenosis

Should we stent it?
POBA vs Stent

- Initial Success: 57% (Balloon) vs 88% (Stent)
- 6 mo Patency: 29% (Balloon) vs 75% (Stent)

*P< 0.05

# Renal Artery Stenting

## Technical Success

<table>
<thead>
<tr>
<th>Study series</th>
<th>No. of Arteries</th>
<th>Ostial Lesion(%)</th>
<th>Success (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rodriguez-Lopez</td>
<td>125</td>
<td>66</td>
<td>98</td>
</tr>
<tr>
<td>Henry</td>
<td>104</td>
<td>77</td>
<td>99</td>
</tr>
<tr>
<td>Rocha-Singh</td>
<td>180</td>
<td>43</td>
<td>98</td>
</tr>
<tr>
<td>Tuttle</td>
<td>148</td>
<td>100</td>
<td>98</td>
</tr>
<tr>
<td>Dorros</td>
<td>202</td>
<td></td>
<td>99</td>
</tr>
</tbody>
</table>

~ 98%

Lim and Rosenfield, Curr Int Cardiol 2000;2:130-9
## Renal Artery Stenting

### Restenosis

<table>
<thead>
<tr>
<th>Study (year)</th>
<th>RA evaluated (% original total a.)</th>
<th>F/U (mo)</th>
<th>Restenosis (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>van de Ven</td>
<td>52 (95%)</td>
<td>6</td>
<td>21</td>
</tr>
<tr>
<td>Rocha-Singh</td>
<td>158 (88%)</td>
<td>13</td>
<td>12</td>
</tr>
<tr>
<td>Rundback</td>
<td>28 (52%)</td>
<td>12</td>
<td>26</td>
</tr>
<tr>
<td>Tuttle</td>
<td>49 (33%)</td>
<td>8</td>
<td>14</td>
</tr>
<tr>
<td>White</td>
<td>80 (60%)</td>
<td>9</td>
<td>19</td>
</tr>
</tbody>
</table>

~20%

*Lim and Rosenfield, Curr Int Cardiol 2000;2:130-9*
Renal Artery Stenting

- Technically Feasible
- Safe & Durable
- Superior to Balloon
Renal Artery Stenting

However, is it effective in improving hypertension & slowing progressive decline in renal function?
Renal artery stenting?

Effect on hypertension
BP Change after Stenting

BP Change by Baseline BP

P < 0.001
R² = 0.43

## Renal Artery Stenting

### Effect on Hypertension

<table>
<thead>
<tr>
<th>Study series (year)</th>
<th>No.</th>
<th>Cure (%)</th>
<th>Improved (%)</th>
<th>Benefits (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tegtmeyer</td>
<td>65</td>
<td>23</td>
<td>71</td>
<td>94</td>
</tr>
<tr>
<td>Klinge</td>
<td>134</td>
<td>10</td>
<td>68</td>
<td>78</td>
</tr>
<tr>
<td>Martin</td>
<td>94</td>
<td>22</td>
<td>46</td>
<td>68</td>
</tr>
<tr>
<td>Lossino</td>
<td>153</td>
<td>12</td>
<td>51</td>
<td>63</td>
</tr>
<tr>
<td>Rodriguez-Perez</td>
<td>37</td>
<td>0</td>
<td>81</td>
<td>81</td>
</tr>
<tr>
<td>Blum</td>
<td>74</td>
<td>16</td>
<td>62</td>
<td>78</td>
</tr>
<tr>
<td><strong>Pooled Result</strong></td>
<td>586</td>
<td>14</td>
<td>63</td>
<td>~77%</td>
</tr>
</tbody>
</table>
Effect on hypertension

Cure 12 ~ 23 %
Improved 46 ~ 81 %
Renal artery stenting

Can We Salvage Renal Function?
Stabilization of Renal Function

Reciprocal serum creatinine plot

Post Stent

Natural course

## Renal Artery Stenting

### Effect on Renal Function

<table>
<thead>
<tr>
<th>Study</th>
<th>No</th>
<th>Improved (%)</th>
<th>Stable (%)</th>
<th>Deteriorated (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van de Ven</td>
<td>42</td>
<td>12</td>
<td>62</td>
<td>26</td>
</tr>
<tr>
<td>Rocha-Singh</td>
<td>150</td>
<td>22</td>
<td>70</td>
<td>8</td>
</tr>
<tr>
<td>Tuttle</td>
<td>129</td>
<td>15</td>
<td>81</td>
<td>4</td>
</tr>
<tr>
<td>Dorros</td>
<td>163</td>
<td>18</td>
<td>48</td>
<td>34</td>
</tr>
<tr>
<td>Rundback</td>
<td>45</td>
<td>20</td>
<td>47</td>
<td>33</td>
</tr>
<tr>
<td>Harden</td>
<td>32</td>
<td>34</td>
<td>38</td>
<td>28</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>561</td>
<td><strong>19%</strong></td>
<td><strong>62%</strong></td>
<td><strong>19%</strong></td>
</tr>
</tbody>
</table>

*Lim and Rosenfield, Curr Int Cardiol 2000;2:130-9*
Renal Artery Stenting

Effect on Renal Function

- Improved: 23 ~ 41%
- Stabilized: 29 ~ 100%
- Deteriorated: 5 ~ 38%
Renal Artery Stenting

- Technically Feasible
- Safe & Durable
- Superior to Balloon
- Effective in improving HTN
- Beneficial to preserve renal function
Renal Artery Stenting
Superior to Surgery?

No Randomized Trials of Renal Artery Stenting vs Surgery
Surgical Revascularization

Aorto-renal bypass
Renal endarterectomy

<table>
<thead>
<tr>
<th>Condition</th>
<th>Rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>Death</td>
<td>2 ~ 6 %</td>
</tr>
<tr>
<td>MI</td>
<td>2 ~ 9 %</td>
</tr>
<tr>
<td>Stroke</td>
<td>0 ~ 3 %</td>
</tr>
<tr>
<td>Bleeding</td>
<td>2 ~ 3 %</td>
</tr>
<tr>
<td>Cholesterol Emboli</td>
<td>1 ~ 4 %</td>
</tr>
</tbody>
</table>

Late Results of Surgery

5 year results

- Graft failure 6 ~ 18 %
- Reoperation 5 ~ 15 %

Renal artery stenting

- Acute success rate > 98%
- Restenosis < 15%
Renal Artery Stenting

- Technically Feasible
- Safe & Durable
- Superior to Balloon
- Effective in improving HTN
- Beneficial to preserve renal function
- Safer than surgery
- FDA approved (July 10, 2002)
Renal artery stenting
Long-Term Survival
Do All Benefit?
Survival after Stenting

Categorized by baseline Creatinine

Survival (%)

- **Cr ≤ 1.5 mg/dl**
- **Cr 1.5~1.9 mg/dl**
- **Cr ≥ 2.0 mg/dl**

Years

Survival after Stenting

Unilateral vs Bilateral Stenosis

*P < 0.01

Survival after Stenting

4 year survival (N=1058)

Baseline creatinine

- Cr ≤ 1.4 mg/dL 85±3% (622)
- 1.5 - 1.9 mg/dL 78±5% (168)*
- Cr ≥ 2.0 mg/dL 49±5% (268)*

*P< 0.05

## Survival after Stenting

### 4 year survival (N=1058)

<table>
<thead>
<tr>
<th>Baseline creatinine</th>
<th>Unilateral</th>
<th>Bilateral</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cr ≤ 1.4 mg/dL</td>
<td>86±3% (397)</td>
<td>85±7% (225)</td>
</tr>
<tr>
<td>1.5 - 1.9 mg/dL</td>
<td>78±7% (103)</td>
<td>78±5% (65)</td>
</tr>
<tr>
<td>Cr ≥ 2.0 mg/dL</td>
<td>49±5% (173)</td>
<td>49±5% (95)</td>
</tr>
</tbody>
</table>

Renal Artery Stenting

Beneficial impact on survival

Renal artery stenting before the onset of renal dysfunction !!!
“Dark side” of Renal Artery Stenting

Atheroembolism...
# Incidence of Atheroembolism

## During Renal Artery Stenting

<table>
<thead>
<tr>
<th>Study</th>
<th>No</th>
<th>Embolism</th>
</tr>
</thead>
<tbody>
<tr>
<td>Van de Ven</td>
<td>42</td>
<td>7 %</td>
</tr>
<tr>
<td>Rocha-Singh</td>
<td>42</td>
<td>5.9 %</td>
</tr>
<tr>
<td>White</td>
<td>150</td>
<td>2 %</td>
</tr>
</tbody>
</table>
Promoting Factors of Atheroembolism

Procedural
- Length of the procedure
- Difficulties of the procedure
- Size of the devices
- Primary stenting
- High pr. dilatation
- Guiding catheter intubation

Clinical
- Elderly (> 60 years)
- Male
- Renal insufficiency
- Multisegment dis
- Associated aorta / peripheral lesions
- Anticoagulants – Fibrinolytic drugs
Distal Protection During Renal Artery Stenting

Will it make a difference?
Should we use it?
Distal Protection  
(Pilot Study)

**Stent with PercuSurge GuardWire**

28 pts, 32 renal arteries (29 ostial lesions)

- Debris retrieved in all (Success 100%)
- At 6-mo F/U,
  
  Renal function deterioration: 0 pts
  Improvement: 5 pts

Distal Protection may prevent renal insufficiency after procedure.

In Conclusion

Renal Artery Stenting

• Effective and Safe
• Sustained Benefit
• Choice for Complex Renal Artery Stenosis
Renal Artery Stenting

In the near future....

Outcomes will be advanced by

- Improved stents/delivery systems
- Distal protection device
- Drug – eluting stent