FFR and Valvular Heart Disease

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Disclosure:

Morton J. Kern, MD

Within the past 12 months, the presenter or their spouse/partner have had a financial interest/arrangement or affiliation with the organization listed below.

<table>
<thead>
<tr>
<th>Company Name</th>
<th>Relationship</th>
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</thead>
<tbody>
<tr>
<td>St. Jude Medical Inc.</td>
<td>Speakers’ Bureau</td>
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<tr>
<td>Volcano Therapeutics</td>
<td>Speakers’ Bureau</td>
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<tr>
<td>Merit Medical Inc.</td>
<td>Consultant</td>
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<tr>
<td>Acist Medical Inc.</td>
<td>Consultant</td>
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<tr>
<td>Opsens</td>
<td>Consultant</td>
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</tbody>
</table>
FFR in Valvular Heart Disease

Factors confounding interpretation of FFR
Coronary Blood flow and Reserve
Left Ventricular Hypertrophy and Strain
Microvascular dysfunction

Theoretical considerations for FFR in TAVR
Why Angina in Aortic Stenosis With Normal Coronary Arteriograms?

K. Lance Gould, MD; Blase A. Carabello, MD
Circulation 2003;107:3121-3123

CFR vs. LVH

CFR vs. Diastolic Perfusion Time

Normals

Flow deficit

Pts with impaired microvascular function

MBF

Graphs showing correlations between CFR and LVH, and CFR and diastolic perfusion time.
Microvascular disease and CBF

CVR vs Diastolic Perfusion Time

Circ 2002;105:470-476
Total and transmural MBF in Ao stenosis: relation to AVA

Ventricular blood flow during hyperemia vs. AVA

CVR vs. AVA

% increase in total ventricular blood flow during hyperemia

AVA (cm²)

y = 224x - 72
r = 0.92; p < 0.0001

AVA (cm²)

y = 2.53 + 1.36ln(x)
r = 0.83; p < 0.0001

y = 2.59 + 2.63ln(x)
r = 0.83; p < 0.0001
Myocardial Blood Flow and Oxygen Consumption in Man Early After Valve Replacement

By James D. Wisheart, M.B., B.Sc., F.R.C.S. (Ed), Joseph P. Archie, Ph.D., M.D., John W. Kirklin, M.D., and William G. Tracy, B.S.

Differences Between Patients in Group A According to the Valve Replaced

<table>
<thead>
<tr>
<th></th>
<th>Mean LAP (Period 1)</th>
<th>LV CBF (Period 2)</th>
<th>LV CBF (Period 3)</th>
<th>MvO₂ / TTI (Period 2)</th>
<th>MvO₂ / TTI (Period 3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Aortic valve replacement (N = 10)</td>
<td>9 ± 1.0</td>
<td>98.0 ± 5.4</td>
<td>96.3 ± 5.8</td>
<td>4.6 ± 0.27</td>
<td>5.0 ± 0.38</td>
</tr>
<tr>
<td>Mitral valve replacement (N = 4)</td>
<td>15 ± 2.3</td>
<td>123.1 ± 6.3</td>
<td>127.2 ± 8.7</td>
<td>6.7 ± 0.42</td>
<td>7.5 ± 0.59</td>
</tr>
<tr>
<td>( P )</td>
<td>&lt; 0.025</td>
<td>&lt; 0.05</td>
<td>&lt; 0.025</td>
<td>&lt; 0.001</td>
<td>&lt; 0.005</td>
</tr>
</tbody>
</table>

Period 1 = pre, period 2 = 2-4h post, period 3 = 1 day post

Circulation, Volume XLIX, May 1974
Coronary Flow Reserve Improves After Aortic Valve Replacement for Aortic Stenosis: An Adenosine Transthoracic Echocardiography Study

David J. R. Hildick-Smith, MA, MRCP, Leonard M. Shapiro, MD, FRCP, FACC

Cambridge, United Kingdom
Table 3. Distal Left Anterior Descending Coronary Artery Flow Velocities and Flow Reserve Before and After AVR

<table>
<thead>
<tr>
<th>Variable</th>
<th>Resting</th>
<th>Hyperemia</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Pre-AVR</td>
<td>Post-AVR</td>
<td>p Value</td>
</tr>
<tr>
<td>PSV (m/s)</td>
<td>0.05 (0.11)</td>
<td>0.16 (0.08)</td>
<td>&lt; 0.01</td>
</tr>
<tr>
<td>PDV (m/s)</td>
<td>0.43 (0.16)</td>
<td>0.41 (0.11)</td>
<td>NS</td>
</tr>
<tr>
<td>VTI (mm)</td>
<td>15.4 (6.7)</td>
<td>13.4 (3.4)</td>
<td>NS</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>70 (11)</td>
<td>73 (9)</td>
<td>NS</td>
</tr>
<tr>
<td>Flow (ml/min)</td>
<td>23.3 (10.1)</td>
<td>20.9 (5.2)</td>
<td>NS</td>
</tr>
<tr>
<td>Flow (ml/min/100 g LV mass)</td>
<td>8.7 (3.8)</td>
<td>9.0 (2.5)</td>
<td>NS</td>
</tr>
<tr>
<td>Coronary Flow Reserve</td>
<td>1.76 (0.5)</td>
<td>2.61 (0.7)</td>
<td>&lt; 0.01</td>
</tr>
</tbody>
</table>
Systemic Vascular Load in Calcific Degenerative Aortic Valve Stenosis: Insight From Percutaneous Valve Replacement

Systemic Vascular Load in Calcific Degenerative Aortic Valve Stenosis: Insight From TAVR

Wave reflections in the coronary circulation, Davies J et al 2006
Wave reflections in the Coronary Circulation, Davies J et al, Circ. 2006
Wave reflections in the Coronary Circulation, Davies J et al, Circ. 2006

Diastolic backward suction wave
Changes in coronary wave intensity analysis in a subject with severe aortic stenosis before and after TAVR

Increase in suction wave with increasing severity of aortic stenosis

$r = 0.62$
$p < 0.04$

Wave intensity $10^5 \text{ W m}^{-2} \text{ s}^{-2}$

Peak aortic valve gradient (mm Hg)

Big increase in suction wave after pacing
Improvement in physiological reserve in subjects with aortic stenosis after percutaneous aortic valve replacement (PAVR).

Severe aortic stenosis
Before PAVR

![Graph showing wave intensity before PAVR](image)

After PAVR

![Graph showing wave intensity after PAVR](image)

Intravenous Adenosine Infusion is Safe and Well Tolerated During Coronary Fractional Flow Reserve Assessment in Severe Aortic Stenosis

Dušan Stanojevic, Prasad Gunasekaran, Micah Levine, Mark Reichuber, Randall Genton, Ashwani Mehta, Matthew Earnest, Mark Wiley, Peter Tadros, Buddhadeb Dawn, Kamal Gupta
Division of Cardiovascular Diseases and the Cardiovascular Research Institute
University of Kansas Medical Center and Hospital, Kansas City, Kansas

Table 1. Comparison of Hemodynamic Profiles of Patients with Severe Aortic Stenosis Undergoing Adenosine Infusion for FFR Estimation

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Baseline</th>
<th>Lowest during Infusion</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Systolic BP (mm Hg)</td>
<td>158.6±26.6</td>
<td>106.4±26.1</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Diastolic BP (mm Hg)</td>
<td>79.7±12.9</td>
<td>61±11.4</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>MAP (mm Hg)</td>
<td>105.8±15.6</td>
<td>75.5±12.3</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>HR (bpm)</td>
<td>76.5±22.9</td>
<td>59.1±12.5</td>
<td>&lt;0.01</td>
</tr>
</tbody>
</table>

BP=blood pressure; HR=heart rate; MAP = mean arterial pressure; FFR=fractional flow reserve; p<0.05 was considered statistically significant
Postulated Physiologic Changes after TAVR for Lesion Assessment

<table>
<thead>
<tr>
<th></th>
<th>Aortic Stenosis</th>
<th>TAVR</th>
</tr>
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<tbody>
<tr>
<td>CFR</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>IMR</td>
<td>↑</td>
<td>↓</td>
</tr>
<tr>
<td>Dia Suction Wave</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>LV Relax</td>
<td>↓</td>
<td>↑</td>
</tr>
<tr>
<td>FFR</td>
<td>↑</td>
<td>↓</td>
</tr>
</tbody>
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Aortic Stenosis

Post TAVR

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University of California - Irvine
Coronary Blood flow in Aortic Valve Disease

FFR and hypertrophy, microvascular dysfunction

Coronary Artery Disease in Valvular Heart Disease

Implications and Future considerations for FFR in Valvular HD