The Mechanism of Arterial Compliance Change and the Value of Acute Luminal Gain

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Disclosures

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What is Compliance?
A measure of distensibility
Goals

• Maximize luminal gain
• Achieve laminar flow (maximize wall shear stress)
• Minimize vessel wall injury
Mechanism of Lumen Enlargement With Balloon Angioplasty

- Predominantly a result of intimal and medial dissection with vessel stretching/enlargement
- Small contribution from plaque area reduction (compression). The degree to which this component is responsible for lumen enlargement is dependent upon plaque composition
- Plaque area and calcification are inversely correlated with compliance
Balloon Angioplasty

Controlled Vascular Injury
Disruption of medial layer
Balloon Angioplasty
Restenosis: Predicted by MLD/MLA

- Early vessel recoil
- Flow-limiting dissection
- Neointimal hyperplasia
- Negative remodeling
Objectives

• Increase lesion/arterial compliance
  - Increase luminal gain
  - Increase patency

• Opposing forces
  - Medial Ca$^{++}$ → ↑ arterial stiffness → ↑ vessel recoil
  - Intimal Ca$^{++}$ → non-uniform lesion rigidity → flow-compromising subintimal dissection
Detection of Ca^{++}

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<th>Coronary Angiography</th>
<th>CT</th>
<th>IVUS</th>
<th>RF-IVUS (IVUS-VH)</th>
<th>OCT</th>
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<td>Superficial calcium detection</td>
<td>Color coded tissue composition</td>
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<td>Sharp delineation of calcium area is possible</td>
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Eccentric Calcium

Insufficient Radial force
Mönckeberg Sclerosis
Good POBA Result in a Compliant Lesion
POBA in Calcified Lesion
74% of lesions which dissect after PTA contain calcium. Dissections occur at points of abrupt compliance transition 87% of the time in calcium containing lesions after PTA.
Focal Force Balloons: controlled dissection

Atherectomy: decrease plaque volume and/or improve compliance

- “Indiscriminate” debulking devices
  - directional atherectomy
  - Jetstream
  - laser
  - Phoenix
- Lesion modification devices
  - orbital/rotational
  - intravascular lithotripsy
PTA of Calcified SFA Lesion
OCT: Dissection at Calcium Shoulder
Orbital atherectomy attempts to achieve a more uniform circumferential compliance which decreases dissection and reduces recoil.
OCT: Minimal Dissection
Intravascular Lithotripsy

Calcium fracture

Ziad A. Ali. Circulation: Cardiovascular Interventions. Safety and Effectiveness of Coronary Intravascular Lithotripsy for Treatment of Severely Calcified Coronary Stenoses, Volume: 12, Issue: 10, DOI: (10.1161/CIRCINTERVENTIONS.119.008434)
Conclusions

• Goal is to increase lesion and vessel compliance and render it circumferentially uniform

• Maximize MLA while minimizing vessel trauma to improve vessel patency
Thank You