Discussion on Physiology of CLI in Utility of DCB in Below-the-Knee (BTK) Procedures

J.A. Mustapha, MD, FACC, FSCAI
Director of Cardiovascular Catheterization Laboratories
Director of Endovascular Interventions
Director of Cardiovascular Research
Metro Health Hospital, Wyoming, MI
Clinical Assistant Professor of Medicine
Michigan State University, E. Lansing, MI
Disclosure

Abbott Vascular - Consultant, Speaker, Medical Advisory Board
Bard Peripheral Vascular - Research, Consultant, Medical Advisory Board, Speaker, Trainer
Bayer - Medical Advisory Board
Biotronik - Research
Boston Scientific - Speaker, Consultant
Cardiovascular Systems, Inc. - Research, Consultant, Speaker, Trainer
Cook Medical - Research, Consulting, Speaker, Trainer
Cordis - Consultant, Trainer
Covidien - Consulting, Speaker, Trainer
Lake Region Medical - Consulting
Terumo - Consulting, Speaker, Trainer
Trireme – Research
Spectranetics – Research, Consulting
• BTK vessels evolved into a complex structure to be able to accommodate the tremendous pressure from the weight of the body.

• Tibial arteries exhibit characteristic features different from above the knee arteries.

• Tibial arteries change their wall structure accordingly and have evolved to deposit the highest amount of medial calcium in their distal anatomy.
Physiology of the Tibial Arteries

Comorbidities such as DM, CKD/ESRD, smoking, and age are associated with transformation of the tibial arteries into three major hostile vessels for therapy:

1. **Severe medial calcification**: Evolved into unique helical plates of calcium that are not connected and spaced. Worse if associated with “JENALI gaps” which are associated with severe medial calcification leading to a fracture and separation “gap.” Interestingly the separated area does not contain calcium.

2. **Intimal calcification**: Tends to evolve into transluminal growth/obliteration with tremendous amount of layered calcium plates within it. These calcium plates are different from the medial calcification as they don’t follow any order and are unpredictable.

3. **Combined medial and intimal calcification**: Is a combination associated with vessel guaranteed to be resistant to any type of therapy including DCB.
Calcium Distribution in BTK Vessels

A recent study (by Mustapha, Virmani, et al) showed the physiological distribution of calcium deposit in the tibial walls vary in densities in both the intimal and medial calcium deposit:

1. More intimal calcium deposits with higher densities located in the proximal tibial arteries.

2. More medial calcium deposits with much higher densities in the distal tibial arteries, especially around the ankle strap.
   1. Most medial wall calcification is present in the distal posterior tibial artery just above the medial maleolous and extending distally just above the plantar bifurcation
   2. Second worse medial wall calcification is present in the distal anterior tibial artery as it becomes the dorsalis pedis artery.

3. Combined medial and intimal calcification is mostly located at the level of the medial tibial arteries.
What Does This Mean for the Proximal Tibial Artery

- More intimal calcium deposit with higher densities located in the proximal tibial arteries.
- Features of intimal calcification are eccentric and concentric calcific plaques that are irregular and long with variable calcium density deposits.

- Start with serial or sequential balloon dilatation
- Intermittent vasodilators
- Atherectomy if available
- Scoring balloons for those that believe in their capabilities

Ossification

Eccentric calcific plaque with ossification

Mustapha, Virmani et al
What Does This Mean for the Distal Tibial Artery

There are more medial calcium deposits with higher densities located in the distal tibial arteries

- Directional atherectomy
- Laser atherectomy
- High pressure prolonged Angioplasty
- Orbital and rotational atherectomy
- Scoring balloons.

Mustapha, Virmani et al
What Makes DCBs Work in BTK Vessels?

Properly Prepared Vessels

• Sizing
• 1:1 pre dilitation
• Switch to short non-compliant balloons if can’t efface waist

DCB
Drug Coated Balloons

**Drug:**
Paclitaxel appears optimal due to lipophilic properties, short absorption time, prolonged antiproliferative effect.

**Excipients:**
Lopromide, urea, polymers, Polysorbate, Sorbitol, nanoparticles.
After balloon inflation 10-15% of the drug remains in the wall 40-60 min later.

**Data:**
Desired pharmacologic levels w/ biologic effects and healing (at early & late time points respectively) without downstream emboli or systemic toxicity have been shown for Lutonix DCB in animals

**Mechanism of Drug Coating**

- **paclitaxel**
  - Drug

- **carrier**
  - Carrier molecule

\[ \text{paclitaxel} + \text{carrier} = \text{Paclitaxel/carrier combo} \]

The carrier molecule plays a PIVOTAL role in drug transfer and stabilization.
1st step after crossing the vessel is to prep the target lesion. Advance a pre-dilatation balloon across the lesion, as shown.
Mechanism of Drug Elution and Proper DCB Utilization for Optimal Results

2\textsuperscript{nd} step is to inflate the pre-dil balloon:

Note the multiple waists on the balloon. These waists need to be addressed prior to advancing the DCB to insure full contact between the DCB and the vessel wall.
3rd step: To ensure proper lesion preparation we apply additional ATM, and high pressure balloon, or scoring balloons/atherectomy devices in very calcified lesions may achieve the ultimate lesion prep by resolving residual waist prior to delivering the DCB.
Mechanism of Drug Elution and Proper DCB Utilization for Optimal Results

The vessel prep is done correctly and the arrows show the many new paths created for the drug transfer to the vessel wall. More important is the resolution of the waists on the pre-dil balloon.
Mechanism of Drug Elution and Proper DCB Utilization for Optimal Results
Mechanism of Drug Elution and Proper DCB Utilization for Optimal Results
Mechanism of Drug Elution and Proper DCB Utilization for Optimal Results
Mechanism of Drug Elution and Proper DCB Utilization for Optimal Results
Thank You

J.A. Mustapha, MD, FACC, FSCAI

Director of Cardiovascular Catheterization Laboratories
Director of Endovascular Interventions
Director of Cardiovascular Research
Metro Health Hospital, Wyoming, MI
Clinical Assistant Professor of Medicine
Michigan State University, E. Lansing, MI