Vascular calcification in peripheral arteries: Implications for device design and procedural success

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Disclosure Statement of Financial Interest

Speaker's name: Aloke, Finn, Gaithersburg

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Figure 1
Atherosclerotic Plaque Progression in Peripheral Arteries

AIT  PIT  FA  TCFA

Rupture  Healed Rupture  Fibrous Plaque  CTO
Intimal Calcification in Peripheral arteries
Figure 2-B

Medial Calcification

A. Movat
B. Movat
C. Movat
D. Movat
E. Movat
F. Movat

Von Kossa
Von Kossa
H&E
H&E
H&E
Atherosclerosis and calcification in human peripheral arteries

- Type of calcification
- Intimal vs. Medial calcification

16 asymptomatic legs (3069 histologic sections) from 12 patients

Mean age 82±4, Male 70%

Torii S. JACC Imaging 2018 Dec 6.
The relationship between % stenosis and plaque type

Above the knee lesion

Below the knee lesion

n=1006

n=1981

0-10% 10-20% 20-30% 30-40% 40-50% 50-60% 60-70% 70-80% 80-90% 90-100%

n=40  n=177  n=133  n=145  n=146  n=142  n=75  n=58  n=45  n=45

n=679  n=270  n=111  n=102  n=86  n=87  n=110  n=130  n=123  n=283

- AIT
- PIT
- Fibrous Plaque
- Fibroatheroma
- Fibrocalcific plaque
- TCFA

- Rupture
- Calcified Nodule
- Healed Rupture/Calcified Nodule/Erosion
- CTO
The relationship between % stenosis and Calcification (non-decalcified arteries)

<table>
<thead>
<tr>
<th>Intimal Calc</th>
<th>Above the knee lesion</th>
<th>Below the knee lesion</th>
</tr>
</thead>
<tbody>
<tr>
<td>(%)</td>
<td>n=589</td>
<td>n=989</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Medial Calc</th>
<th>(%)</th>
<th>(%)</th>
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<tbody>
<tr>
<td></td>
<td>n=120</td>
<td>n=485</td>
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</table>

Legend:
- None
- Microcalcification
- Punctate
- Fragmented
- Sheet
- Nodular
Correlation between calc and %stenosis
Medial and Intimal calcification of the SFA

- Medial calcification appears feathery
- Dense calcium more likely to be intimal

Medial and Intimal calcification images are shown, with annotations indicating feathery and dense calcification.
Mechanism of Calcifications of PAD not well understood

Histology (w/o decalcification)

Calcified Nodule
Propogated Thr
Open Lumen
Medial Microcalc
CTQ
Above the knee (AK) vs. Below the knee (BK)

% stenosis

- AK: 37.2 (21.6-52.6)
- BK: 31.7 (9.5-44.7)

p = 0.2752

% intimal calc

- AK: 12.3 (2.9-16.4)
- BK: 0.7 (0.2-8.0)

p = 0.0164

% medial calc

- AK: 2.5 (0.7-4.6)
- BK: 2.3 (1.1-4.4)

p = 0.9826
Calcification Grade

Prevalence of Calcification by CT Angiography in 60 Symptomatic patients

Calcification in 10 asymptomatic legs.

<table>
<thead>
<tr>
<th></th>
<th>SFA</th>
<th>POP</th>
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</thead>
<tbody>
<tr>
<td>Intimal</td>
<td>70.7%</td>
<td>70.8%</td>
</tr>
<tr>
<td>Medial</td>
<td>88.4%</td>
<td>95.0%</td>
</tr>
</tbody>
</table>

Diabetes and degree of calcification in PAD

DM: 6 legs from 4 Pts, n=1441
non-DM: 6 legs from 4 Pts, n=1546

Intimal calcification
- DM: 2.0% None or Microcalcification, 23.5% Punctate, 15.3% Fragmented, 7.2% Nodular, 52.1% Sheet
- non-DM: 7.7% None or Microcalcification, 11.3% Punctate, 9.9% Fragmented, 69.0% Nodular, 2.1% Sheet

Medial calcification
- DM: 6.4% None or Microcalcification, 6.7% Punctate, 11.5% Fragmented, 6.7% Nodular, 26.0% Sheet
- non-DM: 0.2% None or Microcalcification, 0.5% Punctate, 0.1% Fragmented, 0.1% Nodular, 63.4% Sheet
Why vessels below the knee occlude?

10 in 36 BK vessels (27.8%) are CTO lesions

- Atherosclerosis
- Distal emboli

- 5 CTO lesions

- % intimal calc: p=0.0167
- % medial calc: p=0.4189

26 Patent

10 CTO lesions

Distal emboli
CTO secondary to distal emboli

85 y.o. Male
Smoker, HT, DM
Asymptomatic

CTO secondary to distal emboli

SFA

A

B

C

D

E

F

G

ATA

H

I

J

Rupture

Calc with Bone

Calc

Calc

Calc

Calc

Calc
Calcification is associated with age and disease stage.
Intimal and medial calcification in long SFA CTO lesion: MicroCT images

77-yrs old Male died of CHF with pacemaker implantation, h/o DM, and a smoker.
Calcification worsen the outcome of both DCB and stent

After revascularization of SFA lesion by DCB (In.PACT). 60 Symptomatic Pts, age 65±21, Lesion length 3cm-30cm

153 Symptomatic pts with SFA disease underwent IVUS followed by EVT

Summary

- Intimal Atherosclerosis Calcification is frequently observed in both coronary and lower extremities, and is more common in above the knee.
- Medial calcification is observed in lower extremities, and calcification is especially high in diabetic and renal failure patients.
- In patients with asymptomatic PAD, thrombotic events (calcified nodule and rupture) are exclusively seen in AK.
- BK vessels with CTO lesions frequently occur secondary to both atherosclerosis and distal emboli.
- Calcification medial and intimal does not allow good vessel preparation and the penetration of the drug, is hampered after DCB usage.
- Calcified lesions need a dedicated device that either cracks or removes calcified areas in order to achieve adequate vessel expansion, probably such lesions need DES rather than DCBs.
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Influence of decalcification during sectioning

Non-decalcified

Decalcified (paraffin embedded)

Movat

HE

Calc
Medial Calcification (Mönckeberg’s) in Dorsalis pedis artery
Bone formation in AK and BK
7 in 12 Pts (58.3%)
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