Carotid Plaque Characteristics With Duplex, CT And MRI Can Predict High Stroke Risk Patients With Asymptomatic Carotid Stenosis

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Imaging markers of Vulnerability: Ultrasound

Gray Scale Median (Objective Classification)
(Computer analyzed global echogenicity of the plaque)

Low GSM (<25) / echolucent

Vulnerable / Symptomatic

High GSM (>25) / echogenic

Asymptomatic

Enhanced activity index


Markers of Vulnerability: Ultrasound

J Black Area

Total plaque volume

3D Ultrasound

Khalak S. et al. / J Vasc Surg 2013
Lee W. Ultrasonography 2014
Ahm B. et al. / J Vasc Surg 2017

CEUS with dB-E is indicative of the extent of plaque neovascularisation

Faggioni et al. / Eur J Vasc Endovasc Surg 2011:61:239-48

Imaging markers of Vulnerability: Ultrasound

DEGREE OF STENOSIS + PLAQUE ECHOGENICITY

Identifying the vulnerable patient with carotid stenosis

Clinical information, family history, genetics

+ Imaging

Biological Markers
Kinematic Features of the Arterial Wall

The incorporation of kinematic features like motion synchronisation of the arterial wall have a favorable impact on the performance of image-data driven diagnosis for CAD and vulnerable plaques.

Markers of Vulnerability: TCD

Patients with microemboli at baseline were significantly more likely to experience events.

Markers of Vulnerability: Ultrasound

**ADVANTAGES**
- low-cost
- low-risk
- well-tolerated

**DISADVANTAGES**
- inter- and intraobserver variability
- efficacy of standardised computerised assessments
- limited assessment of a heavily calcified plaque due to acoustic shadowing

Markers of Vulnerability: CTA

**ADVANTAGES**
- calcification
- plaque volume

**DISADVANTAGES**
- calcification artefact

MRI Markers of plaque vulnerability

- Thin fibrous cap
- Large lipid core
- Endoplaque hemorrhage

3 Tesla MRI Studies of plaque regression after statins
Markers of Vulnerability: MRI

**ADVANTAGES**
- Identification of most plaque characteristics with moderate to good agreement
  - high soft tissue contrast
  - high in-plane resolution

**DISADVANTAGES**
- high cost
- low availability, especially for 3-Tesla and 7-Tesla MRI

Markers of Vulnerability: 18F-FDG PET/CT

<table>
<thead>
<tr>
<th>Plaque type</th>
<th>Plaque, n</th>
<th>TBR</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ruptured</td>
<td>315</td>
<td>1.264 (1.286–1.457)</td>
</tr>
<tr>
<td>Thin</td>
<td>584</td>
<td>1.220 (1.391–1.381)</td>
</tr>
<tr>
<td>Thick</td>
<td>279</td>
<td>1.145 (1.000–1.221)</td>
</tr>
<tr>
<td>Calcified</td>
<td>333</td>
<td>1.121 (1.113–1.139)</td>
</tr>
<tr>
<td>Haemorrhage</td>
<td>205</td>
<td>1.138 (1.003–1.473)**</td>
</tr>
<tr>
<td>Lipid</td>
<td>293</td>
<td>1.299 (1.150–1.522)**</td>
</tr>
<tr>
<td>Collagen</td>
<td>347</td>
<td>1.198 (1.094–1.340)</td>
</tr>
</tbody>
</table>

Markers of Vulnerability: MRI

Conclusions I

- Many imaging techniques are now investigating carotid artery stenosis and plaque’s vulnerability and are complimentary to each other.
- Ultrasound is primarily used to assess a plaque’s echogenicity, with good sensitivity in the detection and characterization of vulnerable carotid plaques; however, the accuracy of ultrasound compared with CT and MRI is suboptimum.

Conclusions II

- CT can be used to assess the volume of atherosclerotic plaques and detect ulcerations, providing good detail for morphological analysis and for calcium identification.
- With CT it is difficult to reliably estimate the grade of stenosis and differentiate between soft plaque components.
Conclusions III

- MRI is currently the most suitable imaging technique to characterise features of plaque vulnerability like intra-plaque hemorrhage.
- Drawbacks of MRI are cost, the relatively longer overall study time and sensitivity of image quality to motion effects.

Thank you for your attention

London, Sunday November 17