MRI carotid plaque imaging predicts future stroke in patients with mild to moderate stenosis – ICAD study

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Introduction

• Carotid Endarterectomy reduces risk of recurrent stroke in patients with symptomatic carotid artery stenosis
Introduction

Pooled analysis of NASCET, ECST and VA trials: n = 6092 patients
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<th>Subgroup</th>
<th>Events/patients</th>
<th>RR</th>
<th>95% CI</th>
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<tr>
<td><strong>Sex</strong></td>
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<tr>
<td>Male</td>
<td>92/890</td>
<td>0.46</td>
<td>0.41–0.51</td>
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<tr>
<td>Female</td>
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<td>&gt;12 weeks</td>
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Introduction

- Unstable/vulnerable carotid plaque
- Beyond the luminal stenosis ➔ Plaque imaging

Introduction

Aim & outcomes

• To determine whether MRI-PH can predict future stroke in patients with symptomatic mild-moderate carotid stenosis

• 1° outcome
  – Ipsilateral ischaemic stroke or DWI+TIA

• 2° outcomes
  – Stroke only
  – All recurrent ipsilateral cerebrovascular event
Methods

- Prospective observational study
  - Adults with a recent TIA, stroke or AmFx
  - Symptomatic 30-99% carotid stenosis
  - No planned carotid intervention
  - Excluded if contraindication to MRI, unable to consent, planned CEA

  - Cerebrovascular events, vascular risk factors, comorbidities and medications
  - 6 monthly clinical/telephone follow-up
Methods

• Brain and carotid imaging
  – DTI, FLAIR, DWI, fMRI
  – Time of Flight MRA ± CE-MRA

• MRI carotid wall imaging
  – Coronal $T_1$-weighted 3D MPRAGE (Black-blood and fat-saturation)

• Signal Intensity Ratio $= \frac{SI_{\text{plaque}}}{SI_{\text{muscle}}}$
  – MRIPH+ve if > 1.5
  – MRIPH-ve if < 1.5
Results

Over 4000 were patients screened

38 excluded:
10 did not have MRI
1 poor quality MRI
2 <30% carotid stenosis
5 occluded ipsilateral carotid artery
12 asymptomatic carotid disease
6 contralateral carotid stenosis
2 posterior circulation stroke

190 agreed to participate

152 recruited (92M, 60F)

1 lost to follow-up
17 70-99% stenosis

134 patients in 30-69% analysis
79 males, 55 females. Median age: 76
Results

- MRIPH in ICAD study
Results

- MRIPH in ICAD study
Results

- 47 (35.1%) patients showed ipsilateral MRI-PH
  - Of which 36 were male; $\chi^2 = 9.3$, $P=0.002$

<table>
<thead>
<tr>
<th>Ipsilateral carotid stenosis (P=0.97)</th>
<th>MRIPH positive</th>
<th>MRIPH negative</th>
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<tbody>
<tr>
<td>30-49%</td>
<td>22</td>
<td>40</td>
</tr>
<tr>
<td>50-59%</td>
<td>17</td>
<td>33</td>
</tr>
<tr>
<td>60-69%</td>
<td>8</td>
<td>14</td>
</tr>
</tbody>
</table>

- No other demographic or risk factor was significantly associated with MRIPH presence.
Results

- Follow-up period
  - Median = 656 days, IQR = 349-994
  - For 30-69% stenosis

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<th>MRIPH negative</th>
<th>Total</th>
</tr>
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<tbody>
<tr>
<td>Stroke</td>
<td>8</td>
<td>4</td>
<td>12</td>
</tr>
<tr>
<td>DWI+ TIA</td>
<td>1</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>TIA</td>
<td>1</td>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>AmFx</td>
<td>0</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>CEA</td>
<td>3</td>
<td>2</td>
<td>5</td>
</tr>
<tr>
<td>Death</td>
<td>7</td>
<td>12</td>
<td>19</td>
</tr>
</tbody>
</table>
Results

- Presence of MRIPH
  - Infarction: $HR = 4.4$
    (95%CI 1.36 – 14.43, $P=0.013$)
  - Stroke only: $HR = 4.08$
    (95% CI 1.23 – 13.58, $P=0.02$)

- Controlling for stenosis
  - HR for stroke was $4.69$
    (95%CI 1.40–15.74, $P=0.012$)

![Graph showing cumulative survival against follow-up days with different lines representing different conditions.](image)
Results

- For 50-69% stenosis
  - 72 participants
  - 9 strokes
  - HR = 4.1
    95%CI 1.01 – 16.81, P=0.049
  - Risk difference 35% at 3 years
Results

- For 30-49% stenosis
  - 62 participants
  - 4 infarctions
  - HR = 4.6
    \[95\% CI \ 0.47 \ – \ 44.3, \ P=0.19\]
  - Low power due to number of events
Conclusions

• In symptomatic patients with moderate carotid stenosis, MRI-PH is a significant predictor of future cerebral infarction and stroke.

• This study builds on previous evidence for MRIPH in moderate stenosis*

Conclusions

• MRI-PH status can thus offer decision support when there is clinical uncertainty regarding the benefit of carotid intervention.
  – MRIPH is stable for up to 2 years*

• Inclusion of MRIPH into clinical risk tools.

• Easily accessible and quick technique, MRIPH should be implemented into clinical practice as standard care.

*Simpson et al, AJNR, 2015;
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– Dr Akram Hosseini
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– Dr Mohana Maddula

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