Quantitative Susceptibility Mapping and Vessel Wall Imaging as Screening Tool to Detect Microbleed in Sentinel Headache

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Background

- Sentinel headache (SH) is a sudden, intense, and persistent headache that precedes spontaneous subarachnoid hemorrhage (SAH) by days or weeks.
- Quantitative susceptibility mapping (QSM) is MRI technique that can detect non-heme iron content of brain structures quantitatively.
- QSM could be used to detect microbleeds (MBs) in the intracranial aneurysm (IA) walls associated with SH; however, it is sometimes difficult to visualize IAs completely on QSM because of bonny and air artifact.
- MR-VWI enables the artifact-free visualization of the thickened aneurysm wall as aneurysm wall enhancement (AWE).
- The purpose of this study was to investigate the correlation between the QSM and AWE, based on the hypothesis that AWE could potentially augment QSM during the analysis of unstable IAs with SH.

Methods

- Patients
  - Initial diagnosis of one or more unruptured IAs between November 2017 and June 2019 were prospectively recruited.
  - SH was defined as follows: a sudden onset, extremely severe, or worst headache with persistence.
- Correlation between QSM and SH
  - Positive QSM patients: Subjects who had at least one IA with MBs
  - Negative QSM patients: Subjects who had IA with no detected MBs
  - Image analysis and detection of the MBs and AWE
  - The presence of MBs was evaluated by overlapping MRA images of the IA with QSM images (Fig. 1).
  - The contrast ratio between aneurysmal wall enhancement and pituitary stalk was used to define AWE (Fig. 2).

Results

A total of 40 subjects with 51 unruptured IAs were included in this study.

- Relationship between QSM identified MBs and the presence of SH (Table 1)
  - Positive QSM was found in 11 subjects, with 10 IAs detected and 1 negative.
  - Negative QSM was found in 29 subjects, with 28 IAs detected and 1 negative.
- Relationship between detecting MBs using QSM and AWE (Table 2)
  - QSM detected MBs in all patients with clinical SH, consequently, any unruptured IAs in patients with SH, the presence of MBs on QSM warrants urgent surgical treatment.

Table 1

<table>
<thead>
<tr>
<th>Subjects with presentation of SH</th>
<th>Positive QSM</th>
<th>Negative QSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>11</td>
<td>0</td>
</tr>
<tr>
<td>Negative</td>
<td>0</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 2

<table>
<thead>
<tr>
<th>Microbleeds Detected by QSM</th>
<th>Positive</th>
<th>Negative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Positive</td>
<td>11</td>
<td>11</td>
</tr>
<tr>
<td>Negative</td>
<td>1</td>
<td>28</td>
</tr>
</tbody>
</table>

Discussion

- According to our results, we recommend the strategy of management for IA with SH described in Table 3.
  - QSM could detect MBs in all patients with clinical SH, consequently, any unruptured IAs in patients with SH, the presence of MBs on QSM warrants urgent surgical treatment.
  - On the other hand, negative QSM and/or no AWE on VWI suggest strongly that the unruptured IA has no MBs and therefore reasonable to observe.
  - In cases where IAs are not visualized on QSM, VWI can help guide the treatment.

Table 3 Strategy of management for the IA with SH

<table>
<thead>
<tr>
<th>QSM available</th>
<th>positive</th>
<th>negative</th>
<th>unavailable</th>
</tr>
</thead>
<tbody>
<tr>
<td>AWE positive</td>
<td>Strongly recommended</td>
<td>Might be considered</td>
<td>Might be considered</td>
</tr>
<tr>
<td>AWE negative</td>
<td>Strongly recommended</td>
<td>Conservative</td>
<td>Conservative</td>
</tr>
</tbody>
</table>

Conclusions

- The combinational findings of MR-VWI and QSM can be used reliably in managing patients with unruptured IAs presenting with headaches.
- If proven in larger cohort, this could eliminate the need for LP and help establish an objective diagnosis of SH in subjects with IAs presenting to the emergency department.

Disclosure

Conflict of interest: None