Identification of left atrial fibrosis with MR sequence of Late-Enhancement (LE-MR): preliminary results.

Poster No.: C-0888
Congress: ECR 2013
Type: Scientific Exhibit
Authors: G. Casagranda¹, E. C. dal Piaz², D. Ravanelli², M. Del Greco², U. M. Rozzanigo², M. Centonze²; ¹Trento, TN/IT, ²Trento/IT
Keywords: Cardiac, MR, MR-Angiography, Ablation procedures, Comparative studies, Segmentation, Tissue characterisation
DOI: 10.1594/ecr2013/C-0888

Any information contained in this pdf file is automatically generated from digital material submitted to EPOS by third parties in the form of scientific presentations. References to any names, marks, products, or services of third parties or hypertext links to third-party sites or information are provided solely as a convenience to you and do not in any way constitute or imply ECR's endorsement, sponsorship or recommendation of the third party, information, product or service. ECR is not responsible for the content of these pages and does not make any representations regarding the content or accuracy of material in this file.

As per copyright regulations, any unauthorised use of the material or parts thereof as well as commercial reproduction or multiple distribution by any traditional or electronically based reproduction/publication method is strictly prohibited.

You agree to defend, indemnify, and hold ECR harmless from and against any and all claims, damages, costs, and expenses, including attorneys' fees, arising from or related to your use of these pages.

Please note: Links to movies, ppt slideshows and any other multimedia files are not available in the pdf version of presentations.

www.myESR.org
Purpose

The aim of this work is to identify left atrial fibrosis in a group of consecutive patients with Atrial Fibrillation (AF), using a Late Enhancement Magnetic Resonance sequence (LE-MR), and its validation by comparison with Electroanatomic Mapping (EAM), currently considered the "gold standard" in the evaluation of fibrosis.

The importance of left atrial fibrosis identification has recently been underlined in the Expert Consensus Statement of the Heart Rhythm Society [1], in terms of treatment and prognosis [2].
Methods and Materials

- 22 patients with AF, 18 males, 4 females, mean age 61 years (range 47-74 years)
- One week before RadioFrequency Catheter Ablation (RFCA) patients underwent cardiac MR on 1.5 T scanner (Magnetom, Avanto, Siemens Medical Systems, Erlangen, Germany) with a 12-element body coil. A contrast-enhanced MR angiography, using real-time bolus tracking after a bolus injection of 10 ml of gadobenate dimeglumine (Multihance, Bracco, Milan, Italy 0.1 mmol/kg) at a rate of 2 mL/s, followed by 40 mL of saline flush was acquired to evaluate anatomical complex left atrium-pulmonary veins (LA-PV) in order to perform the integration of DICOM MR images with the EAM system Carto3 (see next point). For the identification of fibrosis (late enhancement or area of signal hyperintensity) was used a 3D inversion recovery respiration navigated, ECG-gated gradient echo pulse echo sequence. Scan started 15 minutes after the contrast agent injection (Fig.1).
- Before RFCA, a detailed 3D bipolar voltage map of LA was registered using EAM system Carto3 (Biosense Webster, Diamond Bar, CA, USA), recording more than 200 points in the LA. Potentials maps were registered onto anatomical reconstructions of LA based on MR images. Normal endocardial voltage values were in the range 0.5-0.9 mV, whereas values below 0.5 mV were considered as illness areas. The functional information is defined by a colored bar that provides an immediate evaluation of atrial electrical activity. Fibrotic areas are identified in red (bipolar voltage <0.05 mV) whereas healthy tissue in purple (bipolar voltage >0.5 mV; Figg. 2-3)
- Two blinded radiologists evaluated the presence of fibrosis on MR images, reaching a consensus in discordant cases. LA was divided in 7 segments (4 ostia of PV, floor, anterior wall, posterior wall-roof): then, a comparison between the two techniques in the ability of identification fibrosis or healthy tissue was made among the 7 segments; anatomical concordance was defined optimal if the match between MR and EAM was 7/7 or 6/7 segments.
- To quantify the degree of agreement between the results obtained with MR and EAM were performed McNemar test and Cohen's kappa statistic, considering statistically significant tests with P <0.05. Finally, we calculated sensitivity (SE), specificity (SP), positive predictive value (PPV), negative predictive value (NPV) and diagnostic accuracy in the classification of LA segments with fibrosis.
Fig. 2: a-d. Comparison between MR images and electroanatomic map to evaluate the anatomical concordance in the identification of atrial fibrosis. a-b LE-MR axial images of the left atrium. c-d. 3D electroanatomic map images integrated with angio-MR (Carto3) in posterior (c) and anterior (d) views; the functional information is defined by a colour code that provides an immediate evaluation of atrial electrical activity. MR images show hyperenhanced areas of fibrosis in the posterior (arrow in a) and anterior (arrow in b) walls. Electroanatomic map confirms the fibrotic areas (arrows in c and d). In this patient the anatomical concordance between the two techniques was considered optimal (7/7 segments).

© - Trento/IT
Fig. 3: a-d. Comparison between MR images and electroanatomic map to evaluate the anatomical concordance in the identification of atrial fibrosis. a-b LE-MR axial images of the left atrium. c-d. 3D electroanatomic map images integrated with angio-MR (Carto3) in posterior (c) and anterior (d) views. LE-MR image (arrow in a) does not show pathological LE closely to the ostium of the left superior PV, otherwise electroanatomic map identified at this level (arrow in c) an area of fibrosis. LE-MR image shows an hyperenhanced area (fibrosis) in the anterior wall of the left atrium (arrow in b), but electroanatomic map shows normal potential (purple) in this localization (arrow in d). In this patient the anatomical concordance between the two techniques was considered low (3/7 segments). Note the artefact frequently observed on the right inferior PV, due to the respiratory navigator positioned on the right hemidiaphragm (arrowhead in b).

© - Trento/IT
Results

- 4 patients were excluded for the poor quality of images. Optimal anatomical concordance was 83% (15/18 patients): in 8 patients was 7/7 segments (Fig. 2) in 7 patients was 6/7 segments; in 2/18 patients the anatomical concordance was 4/7 segments and in one patient was 3/7 segments (Fig. 3).

- The difference in the classification of the segments between the two methods was statistically not significant (McNemar test, P = 0.143); also the correlation between the findings of fibrosis was significant, with Cohen’s kappa index = 0.696 (95% IC: 0.563, 0.828). In the classification of left atrium segments with fibrosis, MR showed a sensitivity (SE), specificity (SP), positive predictive value (PPV), negative predictive value (NPV), and diagnostic accuracy of 86.8% (95% IC: 71.9, 95.6), 86.4% (95% IC: 77.4, 92.7), 73.3% (95% IC: 58.1, 85.4), 93.8% (95% IC: 86.2, 98.0) e 86.5 (95% IC: 79.3, 91.9) (Fig. 4).
<table>
<thead>
<tr>
<th>SEGMENTS</th>
<th>FN</th>
<th>FP</th>
<th>TN</th>
<th>TP</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>RIPV</td>
<td>2</td>
<td>2</td>
<td>9</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>LIPV</td>
<td>1</td>
<td>4</td>
<td>6</td>
<td>7</td>
<td>18</td>
</tr>
<tr>
<td>RSPV</td>
<td>1</td>
<td>0</td>
<td>11</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>LSPV</td>
<td>1</td>
<td>0</td>
<td>11</td>
<td>6</td>
<td>18</td>
</tr>
<tr>
<td>AW</td>
<td>0</td>
<td>4</td>
<td>11</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>PW-R</td>
<td>0</td>
<td>2</td>
<td>11</td>
<td>5</td>
<td>18</td>
</tr>
<tr>
<td>F</td>
<td>0</td>
<td>0</td>
<td>17</td>
<td>1</td>
<td>18</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>5</strong></td>
<td><strong>12</strong></td>
<td><strong>76</strong></td>
<td><strong>33</strong></td>
<td><strong>126</strong></td>
</tr>
</tbody>
</table>

**Fig. 4:** Table shows for each segment analyzed the number of FN, FP, TN and TP of LE-MR compared to EAM (FN=false negative; FP=false positive; TN=true negative; TP=true positive; RIPV= right inferior pulmonary vein; LIPV= left inferior pulmonary vein; RSPV=right superior pulmonary vein; LSPV=left superior pulmonary vein; AW=anterior wall; PW-R=posterior wall and roof; F=floor).

© - Trento/IT
Conclusion

DISCUSSION AND LIMITS

- Results confirm that there is a good correlation between segments of LE-MR and areas of low voltage to the EAM [2-3]. Statistical analysis showed a VPN of LE rather high (93.8%) compared with a considerable number of false positives, which resulted in a PPV of 73.3%; artifacts present in the MR images, such as the often observed in the right inferior PV [4], may have affected results, leading to an overestimation of fibrosis.

- Some comparison studies [5-6] show an EAM spatial error of 5-10 mm; also EAM expresses mainly the voltage endocardial myocytes than epicardial, it means that EAM could not provide accurate data relating to the whole thickness of the atrial wall. So LE-MR could possess a power of identification fibrosis greater compared to EAM.

- There is a high percentage (18%) of uninterpretable images related to poor technical quality. At present, this limitation seems difficult to eliminate, depending on patient compliance, presence of arrhythmias during the examination and difficulty in choosing the correct Inversion Time (TI). Determination of the TI value is carried out on left ventricular wall and not on the atrial wall, because atrial wall is too thin (1-3 mm). Furthermore, long duration of GRE 3D IR Turbo Flash sequence (20 min) makes impossible to change the TI value, which remains bound to the initial choice.

- Study was affected by the "learning curve" in the execution of the sequence of LE-RM and in interpretation of the images and limited sample size of patients.

- The significance of this method has recently been underlined in the Expert Consensus Statement of the Heart Rhythm Society [1]. In fact as proposed by other Authors [2] to quantify the accurate extension of the atrial fibrosis allows to stratify patients in terms of treatment and prognosis.

CONCLUSIONS

Despite the small sample size, LE-MR sequence has proved to be useful for excluding the presence of atrial fibrosis, but weaker for the confirmation of its existence.

The identification of the LE is important in the management of patients candidated to ablation even if further studies are needed to demonstrate the effective reproducibility of the method proposed and its reliability in clinical practice.


6. Malchano ZJ. Integration of cardiac CT/MR imaging with three-dimensional electroanatomical mapping to guide catheter manipulation in the left atrium: implications for catheter ablation of atrial fibrillation. J Cardiovasc Electrophysiol 2006
Personal Information

Giulia Casagranda
Department of Radiology-APSS of Trento
L.go Medaglie d'Oro, 10
38100 Trento
ITALY
Phone 0461/903543
Fax 0461/903501
giulia.casagranda@apss.tn.it