Creating a magnetic resonance imaging ontology

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Context

• MRI:
  – The most versatile diagnostic imaging technic
  – Wide range of vocabulary (semantic interoperability)

• Ontology
  – Web semantic
  – allows Semantic interoperability
  – Already used in a radiological context

- DICOM standard for communication

but not for MRI
study

parameters -> T1, T2, diffusion sequence and medical interpretation of MRI, technical data are

Goal => Create ontology which gives informations for MRI interpretation, extracted from DICOM headers to help radiologists for MRI interpretations
Example

- What are those sequences?
Material and Method

• Domain analysis
  – Analyzing DICOM standard
  – Analyzing DICOM headers of MRI exams
  – Knowledge coming from JEMRIS (MRI simulator)

High concepts needed to be relevant for radiologists
  • Sequence: set of preselected RF occurring in a magnetic field
  • Parameters: technical features that influence MRI results
  • Sequence results: Contrast imaging T1, T2…
Material and Method

- Create the ontology using Protégé 4 owl2
  - Taxonomy
  - Relations
  - Formal definitions with quantitative data (owl2)
- Ontology had been Validated with DICOM headers analysis
  - extracted thanks to OSIRIX
Results
Sequences

The sequences taxonomy free ourselves from constructors terminology

Coherent Gradient Echo

<table>
<thead>
<tr>
<th>Constructor</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Elscint</td>
<td>F SHORT</td>
</tr>
<tr>
<td>Fonar</td>
<td>Field Echo</td>
</tr>
<tr>
<td>GE</td>
<td>GRASS, FGR, FMPGR</td>
</tr>
<tr>
<td>Hitachi</td>
<td>Rephased SARGE, GFEC</td>
</tr>
<tr>
<td>Philips</td>
<td>FFE</td>
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<tr>
<td>Picker</td>
<td>FAST</td>
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<tr>
<td>Siemens</td>
<td>FISP</td>
</tr>
<tr>
<td>Toshiba</td>
<td>Field Echo</td>
</tr>
</tbody>
</table>

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Results
Parameters and Sequence goals

• Parameters
  – Contrast / Resolution/ are Specific of the sequence Goal

• Sequence goal
  – Calibration Sequence
  – Localisation Sequence
  – ContrastSequence (T1, T2, Proton Density, T2 star)
  – Spectroscopy
  – Perfusion Imaging
  – MagneticResonanceAngiography
  – DiffusionImaging
Results

Relations and Formal

- Relations: are to make the linkage between concepts and give a formal definition
  - Sequence
  - Technical Parameters
  - Sequence

- For example **Spin Echo T2 weighted sequence (definition)**
  
  Some ((RT and (Has_Unit some milisecond (Has_Value some float [>=2000])) and (ET and (Has_Unit some milisecond and ()))) and )
Results validation

- DICOM tags had been added

Spin Echo (0018,0020)
RT (0018,0080) > 2000ms
Spin Echo T2 weighted sequence

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Discussion

• This applicative ontology is a good representation of MRI sequences

• During the ontology validation we had to face to problems:
  – DICOM header filling defects
    • Body part examined is almost never mentioned
      – Pb for T1 and T2 calculation / security
    • Sequence names are located into different DICOM tags
      (0018,0020; 0018,0024 (Siemens); 0018,0023 (General Electric)….)

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Conclusion

• The need of semantic interoperability for MRI is obvious

• Difficulties to make an automatic applicative ontology because of missing informations in DICOM headers (could be solved after obtaining DICOM tag locations from constructors)

• **Next step:** to introduce an automatic tool for PACS