Magnetic Resonance and clinical needs

An Update

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Summary

- History: what we know
- Clinical questions
- From anatomy to physiology
- Innovation and imaging
Summary

- History: what we know
- Clinical questions
- From anatomy to physiology
- Innovation and imaging
Did you know?

✓ **Thales of Miletus + Socrates + Plinius**
  ✓ 900 BC Mount Ida (Crete)
  ✓ Cretan shepherd by the name of Magnés, whilst tending sheep on the slopes of Mount Ida, found that his iron tipped crook and the nails of his boots were attracted to the ground.

✓ **Magnesia: North East Greece (Thesalia) vs. Later colonized Ionia (Eastern Magnesias)**

✓ **Magnesia lithos (AKA periclasa).** Oxid magnesium carbonate and iron oxide, alkaline powder used as an anti-acid and in constipation

✓ **Magnetite.** Ferrous oxide. Ferrimagnetism: the uncompensated magnetic moments of the cationic clusters make this mineral a natural magnet
• **Description of the physical phenomenon**
  I. Rabi 1939 (Nobel Física 1944)

• **Detection on the subject**
  F. Bloch, E. Purcell 1946 (Nobel Física 1952)

• **Application of radiofrequency pulses. Spectroscopy**
  R. Ernst 1966 (Nobel Química 1991)

• **Normal / neoplastic tissue difference**
  R. V. Damadian 1971

• **First tomographic image**
  P. Lauterbour 1973 (Nobel Medicina 2003)

• **Tomographic image of a finger**
  P. Mansfield 1975 (Nobel Medicina 2003)

• **First cranial study**
  R. Hawkes 1979

• **First clinical prototype**
Fig. 1.
Cross-sectional line-scan NMR image through the abdomen at L2-3. Arrow indicates mid-line posterior. Left side lies to the left of the illustration. Bright zones correspond in general to high mobile proton content. See Fig. 2 for labelled details.

Fig. 2.
Labelled image of Fig. 1. A = aorta, C = colon, D = duodenum, G = gall-bladder, I = inferior vena cava, K = kidneys, L = liver, P = pancreas, S = spleen, SI = stomach and intestines, V = vertebra. Abdominal muscles and retroperitoneal fat (MF) are seen adjacent to the vertebra.
What has not changed? Safety

Contraindications: mrisafety.com
Ressonance

H1 nuc

Magnetic field

RF

T1: Longitudinal
T2: Transversal

Image

Relaxation

Signal

ERM
What has changed?

Ressonància Nuclear Magnètica
Ressonància Magnètica Nuclear

Ressonància Magnètica
What has changed?

- Patent
  - “The Indomitable”
  - 1972

- RM 3 Tesla
  - Siemens Verio
  - 2012

- Magnetic field Earth: 0.4 Gauss
- 1 Tesla = 10,000 G (x 4000)
- 3 Tesla = 30,000 G (x 12,000)

FDA approval for clinical 7 Tesla end 2017
What has changed?
Morphological era

1979-1983
- First cranial study
- First clinical proto

1985-1995

Morpho+Physio era
- Diffusion
- Perfusion
- Functional MRI

1995-2007

EPI

T2 FLAIR Angio-RM RMf Dinamic LCR ERM
What has changed? Soup of sequences
Summary

- History: what we know
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Importance of the clinical question

- 50 cases emergency CT
- 19 change the report after knowing clinical information
- In 10 cases it improves accuracy

The diagnosis by the image confirms clinical hypotheses, but keep in mind that there is a knowledge bias (only what is known is known), there is a selection bias (according to the clinician who studies the patient) ...
Example:
biomarkers to assess the probability of thrombus lysis in acute stroke

<table>
<thead>
<tr>
<th>Vaso ocluido</th>
<th>ACI</th>
<th>M1 prox</th>
<th>M1 distal</th>
<th>M2</th>
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</thead>
<tbody>
<tr>
<td>Longitud trombo</td>
<td>&gt; 12</td>
<td>8 – 12 mm</td>
<td>&lt; 12</td>
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<tr>
<td>Clot Burden Score</td>
<td>1,2,3,4,5</td>
<td>6</td>
<td>7,8,9</td>
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<tr>
<td>r Unidades Hounsfield</td>
<td>&lt; 1.382</td>
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<td>&gt; 1.382</td>
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<td>Flujo residual trombo</td>
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<tr>
<td>Circulación colateral</td>
<td>&lt; 10</td>
<td>11-16</td>
<td>&gt; 16</td>
<td></td>
</tr>
<tr>
<td>ACI extracranial</td>
<td>Ocluida</td>
<td>Estenosis</td>
<td>Normal</td>
<td></td>
</tr>
</tbody>
</table>

*Probabilidad recanalización tras rt-PA*
Summary

- History: what we know
- Clinical questions
- From anatomy to physiology
- Innovation and imaging
Anatomy

- Whole body MRI: oncologic, inflammatory or vascular diseases
- Angiovascular
- High resolution anatomy
- Fast imaging: Brain MRI stroke < 10’, Lumbar Spine < 5’, motion MRI
Whole body: applications

- Paediatrics
- Oncology
- Lymphoma
- Solid tumors
- Sdes. Liking cancer
- Neurofibromatosis
- Osteonecrosis
- Dermatomyositis
- Cysticercosis

*Whole-Body MR Imaging in Children: Principles, Technique, Current Applications, and Future Directions*

Govind B. Chavhan, RadioGraphics, October 2011
Inferior leg MR-angio
3Tesla temporal lobe anatomy
Arterial plaque “histology”
Cardio MRI
Physiology

- Water diffusion
- Oxygen
- Flow
**Diffusion Weighted Image**

- **1986**
  - MR Imaging of Intravoxel Incoherent Motions: Application to Diffusion and Perfusion in Neurologic Disorders

- **1990**
  - Fast magnetic resonance diffusion-weighted imaging of acute human stroke

- **1992**
  - Ultra-fast technique EPI RM
  - Sensitive to changes in the microscopic random movement of water molecules in certain media and circumstances
  - Brownian movement described by Einstein in 1905
\( t = 0 \)

\( b = 0 \)

\( t = 1 \)

\( b = 500 \)

\( b = 1000 \)
Diffusion Tensor MR Imaging and Fiber Tractography: Theoretic Underpinnings
P. Mukherjeea, J.I. Bermana, S.W. Chunga, C.P. Hessa and R.G. Henrya
AJNR 2008
$t = 0$

$b = 0$

Mantiene la señal

$M = 1000$

$M = 1000$
Edema citotóxico

Inf. agudo  Hipoglicemia  Status  Encefalitis
Alta densidad celular

Linfoma SNC  Astro Grado III  GBM

H2Ov
PET vs DWI whole body
Absceso p.  Metástasis  Epidermoide  Hematoma ag.  GBM
Anisotropic, restricted diffusion
(coherent axonal bundle)

\[
\begin{bmatrix}
D_{xx} & D_{xy} & D_{xz} \\
D_{yx} & D_{yy} & D_{yz} \\
D_{zx} & D_{yz} & D_{zz}
\end{bmatrix}
\]

Diffusion Tensor MR Imaging and Fiber Tractography: Theoretic Underpinnings
P. Mukherjeea, J.I. Bermana, S.W. Chunga, C.P. Hessa and R.G. Henrya
AJNR 2008
Isotropy

ANIsotropic

Melhem, AJR 2002
Hagmann, Radiographics 2006
\[ \lambda_1 = \lambda_2 = \lambda_3 \]

\[
\bar{\lambda} = \frac{\lambda_1 + \lambda_2 + \lambda_3}{3} \]

\[ \lambda_1 > \lambda_2 > \lambda_3 \]
Anisotropy fraction 0 to 1
Color code

Red: LATERAL
Green: ANTERO-POSTERIOR
Blue: CRANEOL-CAUDAL
From eigenvector to tract
Association
- Upper longitudinal fascicle
- Arcuate Fascicle
- Bottom longitudinal fascicle
- Cingulate
- Uncinate Fascicle

Commissural fascicles
- Corpus callosum
- Anterior comisure

Projection fascicles
- Fornix
- Internal capsule
“Whole brain tract”
Limitations

- Susceptibility artifacts
- Fyber cross
- Computation

Principles and Limitations of Computational Algorithms in Clinical Diffusion Tensor MR Tractography
Chunga, AJNR 2010
Tensor imaging applications
Age-related Degradation in the Central Nervous System: Assessment with Diffusion-Tensor Imaging and Quantitative Fiber Tracking

Andreas Stadlbauer, PhD, Erich Salomonowitz, MD, Guido Strunk, PhD, Thilo Hammen, MD, and Oliver Ganslandt, MD

Fiber Density Index Correlates with Reduced Fractional Anisotropy in White Matter of Patients with Glioblastoma

Tim P.L. Roberts, Fang Liu, Andrea Kassner, Susumu Mori, and Abhijit Guha
✓ Pregnant woman
✓ Left hemiparesia
✓ Lateral amiotrophic sclerosis

Toosy A T et al. J Neurol Neurosurg Psychiatry 2003;74:1250-1257
✓ Lacunar stroke
✓ Relationship stroke with the corticospinal tract

FA=0.24
✓ 33 y.o. woman
✓ Left handed
✓ Conduction aphasia and hemiparesia

✓ Baló type lesion (demyelinating)
Relationship

Paresia
Corticospinal tract

Conduction aphasia
Arcuate fasciculus
Spinal cord

MR Diffusion Tensor Imaging and Fiber Tracking in 5 Spinal Cord Astrocytomas

D. Ducreux*, J.-F. Lepeintre*, P. Fillard*, C. Loureiro*, M. Tadié* and P. Lanjouwia*
IVIM

Figure 2: Diffusion MR imaging signal attenuation. Left: The natural logarithm of the signal attenuation shows a triple curve. At low $b$-values (less than 200 seconds/mm$^2$), the curve results from IVIM blood microcirculation effects. The IVIM has been set to 1%. At very high $b$-values, the signal receives a "noise floor" which produces a curve that needs to be removed before signal analysis. The curvature visible at high $b$-values after noise correction indicates that the diffusion length expected for true diffusion is proportionally reduced by noise effects (mainly from motion), which may confuse with a non-Gaussian distribution. The kurtosis model is one approach that allows the non-Gaussian diffusion effect to be quantified. At lower $b$-values the signal attenuation is nearly straight, as with Gaussian diffusion. The slope obtained by using two $b$-values such as 200 and 1000 seconds/mm$^2$ is smaller than the Gaussian diffusion component of the signal ADC, which is observed by removing the non-Gaussian component. For instance, using the kurtosis model, Eq. (3).

Right: Since the IVIM effect is usually small, more images are often acquired at lower $b$-values than for diffusion or high $b$-values. However, it may be difficult to visually quantify the goodness of the diffusion and IVIM fit using the standard attenuation plot (b-scan) as a function of $b$-value, as in the left plot, where the signal intensity. An attractive alternative would be to plot it as a function of $b$-value to visually exaggerate the contribution of IVIM effects at very low $b$-values.

Figure 3: Logarithm of relative signal intensities. A) The image shows a cross-section of a tumor (T) and liver (L) in a diffusion-weighted MR scan. B) The graph plots the logarithm of relative signal intensities as a function of $b$-value. The lines represent the signal intensity of the liver and tumor, with the liver having a higher signal intensity compared to the tumor at low $b$-values. The graph helps in distinguishing between the two tissues based on their different diffusion properties.
Physiology

- Water diffusion
- Oxygen
- Flow
Magnetic susceptibility

- Magnetic response of tissues placed in an external magnetic field

- Intrinsic property of tissue

- The macroscopic effect (geometry effect) configuration of tissues, (white matter tract, capillary, interstitial space, ...) distorts the homogeneity of the local field

- The microscopic effect is described as the homogeneity of the local field being distorted by substances with different magnetic susceptibility

- Magnetic susceptibility-induced field perturbation: “image artifacts” in magnetic resonance imaging (MRI)
Magnetic properties

a) Diamagnetic
   - $X < 0$ repulsed by external magnetic field
   - Calcium, oxygenated hemoglobin, water, diamond
   - White matter (myelin)

b) Paramagnetic
   - $X > 0$ attracted to external magnetic field
   - Iron, magnesium, aluminium, ferritin containing ferric iron, deoxygenated hemoglobin, and ceruloplasmin
   - Grey matter (iron content)

c) Ferromagnetic
   - $X \geq 0$ and retain magnetization
   - Neodinium
Microstructure brain tissue gray vs white matter
Susceptibility effects in MRI

1. Dipole effect
2. Reducing T2* by increasing local field inhomogeneity
3. Signal dropouts and distortion at boundary with large susceptibility difference
4. Blood Oxygenation Level Dependent (BOLD) effect
Susceptibility effects in MRI

1. Dipole effect
2. Reducing $T2^*$ by increasing local field inhomogeneity
3. Signal dropouts and distortion at boundary with large susceptibility difference
4. Blood Oxygenation Level Dependent (BOLD) effect
Susceptibility effects in MRI

1. Dipole effect
2. Reducing T2* by increasing local field inhomogeneity
3. Signal dropouts and distortion at boundary with large susceptibility difference
4. Blood Oxygenation Level Dependent (BOLD) effect
History

- Air-tissue susceptibility artifacts since beginning MR
- High resolution BOLD venography
  - Ogawa BOLD 1990’s
  - Haacke 1997
- Susceptibility weighted image
  - Patented 2002 Siemens
  - Formal publication 2004, Haacke, MRM
  - Became product Siemens 2007, later on GE and Philips
MRI images are comprised of **multiple scalars**

- **Magnitude of scalars** used to reveal physical or physiological contrast (T1, T2, T2*, ...)

- **Phase scalars** also contains physical and physiological info.
  - Usually used indirectly
Magnitude

- Information of the **vector length**
- Imantation in each voxel
- Inhomogeneity of field
- In veins + hypointense the voxel with change in susceptibility
Phase

- Vector angle information
- MRI two systems: right or left handed
Post-processing

- Phase mask
- High pass to filter field inhomogeneity

Modified Haacke, 2009
Post-processing

✓ Projection
✓ Minimal intensity
Clinical applications

<table>
<thead>
<tr>
<th>Vascular</th>
<th>Trauma</th>
<th>Tumor</th>
<th>Deposition</th>
</tr>
</thead>
<tbody>
<tr>
<td>✓ Thrombus detection</td>
<td>✓ Diffuse axonal lesion</td>
<td>✓ Boundaries</td>
<td>✓ Dementias</td>
</tr>
<tr>
<td>✓ Perfusion (veins)</td>
<td>✓ Subarachnoidal hemorrhage</td>
<td>✓ Calcium vs blood</td>
<td>✓ MS</td>
</tr>
<tr>
<td>✓ All kind of hemorrhages</td>
<td></td>
<td>✓ RDT induced changes</td>
<td>✓ ALS</td>
</tr>
<tr>
<td>✓ AVM, DVA or fistula</td>
<td></td>
<td>✓ Ruptured dermoid</td>
<td></td>
</tr>
</tbody>
</table>

a) Intravascular Hb
b) Extravasation of Hb
c) Intracellular deposition
Veins anatomy
Acute ischemic stroke

- Vein as biomarker of arterial ischemia
- Regional increase of $O_2$ extraction
- Increase of deoHb in local and regional veins

Munuera, JNNP 2016

<table>
<thead>
<tr>
<th></th>
<th>Hypointense veins + (n=10)</th>
<th>HV ++ (n=14)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Volume DWI</td>
<td>12,19 [5.31-18.55]</td>
<td>20.29 [10.96-34.86]</td>
<td>0.030</td>
</tr>
<tr>
<td>Volume Tmax 6</td>
<td>73.96 +/- 46</td>
<td>132.39 +/- 64.96</td>
<td>0.020</td>
</tr>
<tr>
<td>Good collateral</td>
<td>4 (40%)</td>
<td>8 (57%)</td>
<td>0.680</td>
</tr>
<tr>
<td>NIHSS basal</td>
<td>19 [12-21]</td>
<td>17 [7-20]</td>
<td>0.447</td>
</tr>
</tbody>
</table>
Lesion characteristics: Sturge-Weber
Iron deposition

Abnormal accumulation in:

- Huntington’s disease (HD)
- Parkinson’s disease (PD)
- Alzheimer’s disease (AD)
- Multiple sclerosis (MS)
- Chronic hemorrhage
- Cerebral infarction
- Down syndrome
- AIDS

Lesion characteristics: abscess versus glioblastoma

**Differentiation of Pyogenic Brain Abscesses from Necrotic Glioblastomas with Use of Susceptibility-Weighted Imaging**

**BACKGROUND AND PURPOSE:** A common imaging finding in brain abscess and necrotic glioblastomas is a T2 hypointense rim. The features of this hypointense rim on SWI have not been previously described, to our knowledge. We aimed to differentiate abscesses from glioblastomas by assessing the morphologic features of their lesion margins by using SWI.

**MATERIALS AND METHODS:** T2WI and SWI were performed in 12 abscesses and 20 mm-enhancing glioblastomas. On T2WI and SWI, the prevalence and the border types (complete versus incomplete) of hypointense rims were qualitatively assessed. On SWI, the contour (smooth versus irregular) and the location of hypointense rims relative to the contrast-enhancing rims as well as the prevalence of the “dual rim sign,” defined as 2 concentric rims of lesion margins with the outer one being hypointense and the inner one hypointense relative to cerebrospinal fluid, were also analyzed.

**RESULTS:** Prevalence and the border types of the hypointense rims on T2WI were not different between abscesses and glioblastomas. On SWI, there were significantly more hypointense rims that were complete (<0.001) and smooth (<0.001), having the same location as the contrast-enhancing rims (P < 0.001) for abscesses. A dual rim sign was present in 5 of 12 abscesses but absent in all glioblastomas (P < 0.001).

**CONCLUSIONS:** SWI may be helpful in differentiating pyogenic abscesses from necrotic glioblastomas. The dual rim sign is the most specific imaging feature distinguishing the 2.

<table>
<thead>
<tr>
<th>Features</th>
<th>Abscess</th>
<th>GB</th>
<th>P Value</th>
<th>SEN</th>
<th>SPE</th>
<th>Accuracy</th>
<th>PPV</th>
<th>NPV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypointense rim</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Prevalence</td>
<td>Absent</td>
<td>0</td>
<td>5</td>
<td>0.053</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Absent</td>
<td>12</td>
<td>19</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Border</td>
<td>Incomplete</td>
<td>1</td>
<td>13</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Complete</td>
<td>11</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Contour</td>
<td>Smooth</td>
<td>9</td>
<td>7</td>
<td>&lt;0.01</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Irregular</td>
<td>3</td>
<td>13</td>
<td></td>
<td></td>
<td></td>
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<td></td>
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<tr>
<td>Location</td>
<td>Inner</td>
<td>0</td>
<td>9</td>
<td>&lt;0.01</td>
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<tr>
<td>Same</td>
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<td>2</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>Inner + Same</td>
<td>1</td>
<td>4</td>
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<tr>
<td>Dual rim sign</td>
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<td>3</td>
<td>20</td>
<td>&lt;0.01</td>
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<td>Hypointense rim</td>
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<tr>
<td>Prevalence</td>
<td>Absent</td>
<td>0</td>
<td>5</td>
<td>0.053</td>
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<td></td>
<td>Border</td>
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<td>1</td>
<td>13</td>
<td>&lt;0.01</td>
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<td>Complete</td>
<td>11</td>
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<td>9</td>
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<td>&lt;0.01</td>
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<td>Irregular</td>
<td>3</td>
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<tr>
<td>Location</td>
<td>Inner</td>
<td>0</td>
<td>9</td>
<td>&lt;0.01</td>
<td></td>
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<tr>
<td>Same</td>
<td>11</td>
<td>2</td>
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<tr>
<td></td>
<td>Inner + Same</td>
<td>1</td>
<td>4</td>
<td></td>
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</tbody>
</table>

**Note:** GB indicates glioblastoma; SEN, sensitivity; SPE, specificity; PPV, positive predictive value; NPV, negative predictive value.

**A** Imaging features selected for the calculation of SEN, SPE, PPV, and NPV.

**B** Relative to the contrast-enhancing rims.

Abscess: SWI border smooth, dual
Cortical iron deposition: Alzheimer disease

✓ 15 Alzheimer disease patients vs. 15 volunteers

✓ Cortical and deep nuclei measurements (ROI)

✓ Iron concentration in parietal cortex correlates with severity
Cortical iron deposition: amyotrophic lateral sclerosis

- 23 ALS vs. 10 control (AD)
- Mean on cortical motor signal – cingular cortex:
  - Assymmetrical cases: 170
  - Non-assymetrical: 100
  - Control: 40

<table>
<thead>
<tr>
<th>Level intensity</th>
<th>ELA</th>
<th>AD</th>
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<tr>
<td>&gt;70</td>
<td>11</td>
<td>3</td>
</tr>
<tr>
<td>&lt;70</td>
<td>4</td>
<td>7</td>
</tr>
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</table>

Sens: 73%  
Esp: 70%  
PPV: 78%  
NPV: 64%

Diagnosis of ALS cortex vs CST signal
Blood Oxigen Level Dependent

- Increase neuronal act
- Increase $O^2$ extraction
- Increase perfusion
- Increase venous $O^2/CO^2$
- Increase T2* signal

Visual stimulation (Kwong et al. 1992)

Graph showing oxyHb Concentration over TIME (s)

Images of brain scans with time annotations.
During the realization of a paradigm that alters phases of activation and rest, the MR signal is collected and differences are established between the two phases from a t-test.
Somatotopia

RM Bold. Homúnculus Penfield: Motor Area 4 Brodmann
1. **Proprioceptive sensitivity**
   - information about the member's position
2. **SMA and premotor cortex**
   - program the motor act (direction, speed)
3. **Primary motor area**
   - execute the movement
Primary visual cortex
✓ Left handed
✓ FAS paradigm
✓ Words with F, A and S
Do you remember this case?

- Motor task: finger tapping
- Combination with tractography
Multiparametric MRI

Hand

Tongue

CST

Angio

Pre-surgical AVM MRI
Physiology

- Water diffusion
- Oxygen
- Flow
1. Tag inflowing arterial blood by magnetic inversion
2. Acquire the **tag image**
3. Repeat experiment without tag
4. Acquire the **control image**
5. Subtract: **Control image** - **Tag Image**

The **difference** in magnetization between control and tag conditions is proportional to regional cerebral blood flow.

\[ \text{Control image} - \text{Tag Image} = \propto \text{CBF} \]
ASL is an EPI sequence!!!
ASL

- ASL dinam
- ASL selective
- ASL velocity
ASL

TACI <4.5h
rtPA

Fast lysis

Slow flow

Hypoperfusion
Epilepsy

- During seizure
AVM

Arterial steel
4D angioMRI with contrast

Acute stroke dynamics

Dynamic Magnetic Resonance Angiography Provides Collateral Circulation and Hemodynamic Information in Acute Ischemic Stroke

Hernández-Pérez et al., Stroke 2016
Drainage of transversal sinus

Symmetrical

Slow drainage

Non-symmetrical

Fast drainage
4D phase contrast flow
Summary

- History: what we know
- Clinical questions
- From anatomy to physiology
- Innovation and imaging
New challenges

- Artificial Intelligence integrated in medical process
- From 2D to 3D to “digital realities”
- Patient-experience and education
Future challenges:

1. Implement artificial intelligence programs as medical support
2. Determine "authorship" in the BIG DATA
3. Optimize resources vs. innovation
4. Collaboration company-hospital-university
5. Digitization vs. humanization
Computer-aided radiology

Clinical decision
Appropriateness criteria

Radiological decision
Radiology gamuts

Quanty biomarkers
Structured report

• Good clinical practice
• Equipoise
• Evidence based radiology (ACR)

• Infinite memory
• Teaching

• Individual tracking
• Prognostic value
• Research

• Standardization
• Teaching
• Communication
• Research

Adaptation of Understanding the Patient's Perception – Imaging 2.0 vs. Imaging 3.0
Printing 3D HSJD

- 46 Surgery
- 2 Products
dev
- 5 Publications
- 1 PhD

Since 2014

Sant Joan de Déu ensaya una operación complicada con una maqueta
- La intervención era complicada porque podía causar importantes secuelas al paciente
- Los cirujanos han sacado un tumor a un menor después de practicar con una reproducción en 3D

La robótica desarrolla un papel clave en los avances médicos
- El pediatra y cirujano Lukas Krauel ha explicado en la segunda jornada de Global Robot Expo cómo la impresión 3D ha mejorado los resultados de las cirugías en casos de tumores abdominales en niños
QuirofAM RIS3CAT
Ecosistema d’R+D+i per la implementació i adopció de la Fabricació Additiva/Impressió 3D a la indústria catalana

UNIÓ EUROPEA
Fons Europeu de Desenvolupament Regional

ACCIÓ
Generalitat de Catalunya

Interreg Sudoe
EUROPEAN UNION

Osakidetza
health research institute

Biocrucés

Mizar

Sant Joan de Déu

Innova
SERVEI 3DP
HSJD
3D planning in craniofacial surgery (congenital malformations and craniosynostosis)
(Dr. Josep Rubio – Maxillofacial Surgery, Dra. García and Dra. Alamar - Neurosurgery)
First MR-CT Phantom printed in-site
(material study, optimization of sequences, radiation dose,...)
HUMagnet

Humanization and Magnetism

Diagnostic Imaging Department

Hospital Sant Joan de Déu, Barcelona
Scientific education

1. Combine the concepts of the universe and the phenomenon of the magnetic field

2. Explain unknown phenomena related to magnetism
There are several examples of the importance of magnetic fields in the universe and on our planet. We use these ideas to create some “did you know?” examples...

*first own review of scientific papers*
Magnetic fields lines

Milky Way (Plank telescope)

Magnet

MRI
Did you know that some planets can have several magnetic poles?

Did you know that some animals migrate following the magnetic fields of the earth?
At the hallway we explain the equivalence between a magnet, the sun and a MRI.
This is the MRI room.
The design was made to be ambiguous. Thus, a very small child sees striking colors. Childs can see the sun and the orbits of the planets. And young can still understand the concept of positive and negative charges and fields of magnetism.
5 Gauss line
“Non-digital innovation”

1. Creation of a character to explain scientific ideas and also informed consent
2. Donation of Norma editorial of more than 250 comics for the hospital
3. Creation of a comics library in the department
Augmented reality: education magnetism
Augmented reality and safety
Results: pilot study

Inclusion period analysis 3 months 2017

325 patients with MRI + anesth
51 selected patients
38 without
12 with
1 repeated with anesthesia

Clinical criteria to be anesthetized
Reduction 12% anesthesia
75% success

What have we learned?

Increase of 24% MRI activity

Decrease of 10% MRI with anesthesia

Improve the information to medical petitioners and families about the possibility of doing MRI without anesthesia

Only one patient was recited

now we apply the patient-experience algorithm
We must collaborate

✓ translational science
✓ do we share software?
✓ do we share mathematical models?
✓ We need to share knowledge!!!