

European Course on
Pediatric Neuroradiology in
Latin America (ECPNR-LATAM)
3rd Cycle - Module 1

MR Spectroscopy Practical Applications



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MR Spectroscopy Practical Applications

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There is no conflict of interest in this presentation

MR Spectroscopy (MRS) Practical Applications

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- MRS basic concepts
- Technical acquisition considerations
- Practical applications of MRS

Review Article on Pediatric Neuroradiology for Trainees and Fellows: An Updated Practical Guide

MR spectroscopy in pediatric neuroradiology

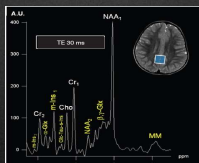
Roberto Liserre¹, Lorenzo Pinelli¹, Roberto Gasparotti²

Transl Pediatr 2021;10(4):1169-1200 | <http://dx.doi.org/10.21037/tp-20-445>

MRS Basic concepts

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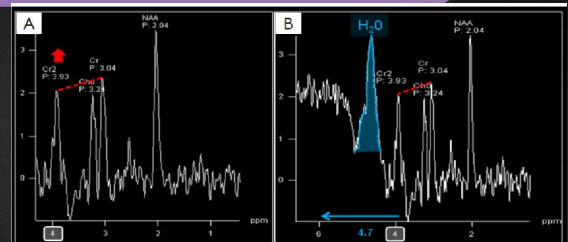
- H¹MRS (proton MRS) is the most clinically used (Others: C-13, F1-19, P-31)
- MRS provides a chemical shift map (x-axis) that locates the metabolites based on their resonance properties. By convention, Tetramethylsilane (TMS) (a constant metabolite) is located at 0 parts per million. The other metabolites are situated in relation to TMS.
- y-axis: Represents concentrations of the metabolites (amplitude)



Normal MRS: narrow peaks (not fused or duplicated)

Artifacts: Motion

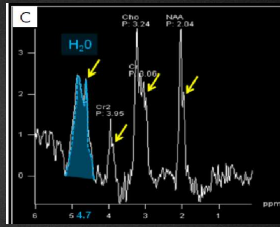
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5yo with mild psychomotor retardation: noisy fluctuating baseline, an abnormally high Cr2 peak (3.93 ppm), increased width of spectral line (linewidths), frequency shifts, and poor water suppression (peak at 4.7 ppm)

Artifacts: Motion

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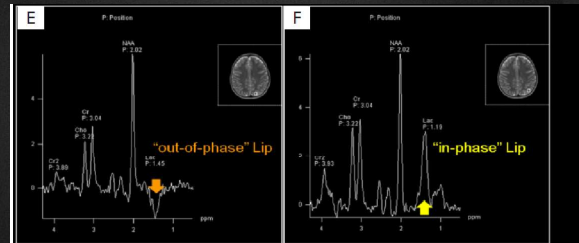


5-month-old infant with epilepsy generates a doubling of all singlet peaks (thin yellow arrows) and an overlap of Cr1 and tCho resonances

Translational Pediatrics, Vol 10, No 4 April 2021

Contamination from the adjacent bone marrow

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MRS: Metabolites

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- **NAA (2.02ppm):** marker of neuronal/axonal integrity
- **tCho (3.2 ppm):** marker of membrane turnover, increased in neuroglial proliferation and tumors
- **Cr (3.01 and 3.91 ppm):** Marker of ATP levels (energy), concentration is stable in a vast majority of brain pathological conditions; therefore, it is the peak of reference
- **m-Ins (3.56-3.57):** astroglial marker, visualized in short TE (might be increased in gliomas)

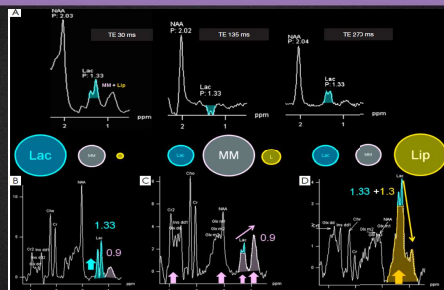
MRS: Metabolites

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- **Glx (2.0-2.6, 3.5, 3.9 ppm):** Glutamate (excitatory neurotransmitter, neurons), Glutamine (precursor of Glu, axons). Glx complex is elevated in hypoxic states and in hyperammonemia
- **Lip + MM (0.9 and 1.3 ppm and many others):** Marker of necrosis or lipid storage. On short TE, can overestimate (Cr2, Lac, Glx, NAA). Signal suppressed at intermediate/long TE in normal brain tissue.
- **Lac (1.33 ppm):** Increases when Lactate oxidation in the Krebs cycle is impaired (hypoxia or mitochondrial diseases). Non-specific (also seen in tumors, inflammatory processes, demyelination, necrotic tissues, etc)

MRS: J coupling phenomenon

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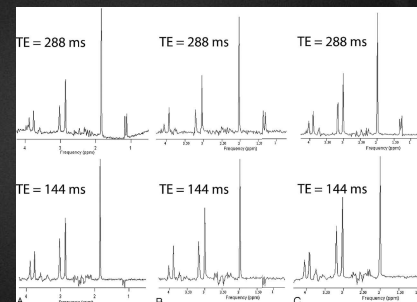
Neonate with moderate HIE, positive lac Lip and MM suppressed at TE 135 and 270 ms

Mitochondrial encephalopathy Short TE Demyelination and atrophy Short TE Extensive necrosis in sulfite oxidase deficiency Short TE

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MRS acquired from a standard brain metabolite phantom containing 5 mmol/L of lactate 3T

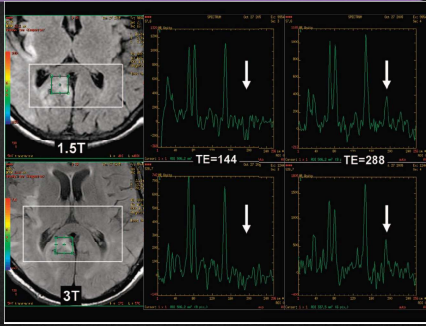
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Lange T, et al. AJNR Am J Neuroradiol 2006;27:895-901

MRS: magnet field and lactate

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Lange T, et al. AJNR Am J Neuroradiol 2006;27:899-901

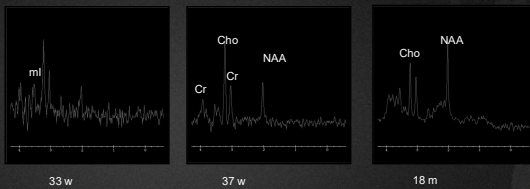
MRS: Short/intermediate/long TE

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- **Short TE (20-40):**
 - Detects more metabolites: Glu-Gln (Glx), lip, and MM
 - Increases the J-coupling phenomenon and base distortion
- **Intermediate TE (97-144 ms):**
 - Preferred TE for clinical practice in 1.5T
 - Less baseline distortion compared with short TE
 - Robust information given on only a few metabolites (NAA, tCho, Cr, Lac)
 - Suppress normal concentrations of MM and Lip
 - Differentiation well Lac from Lipa and MM in 1.5T
- **Long TE (270-288 ms):**
 - Suppress normal concentrations of MM and Lip
 - Proper identification of Lac at 3.0 T
 - Significant loss of signal, → higher acquisition times

Brain MRS along lifespan

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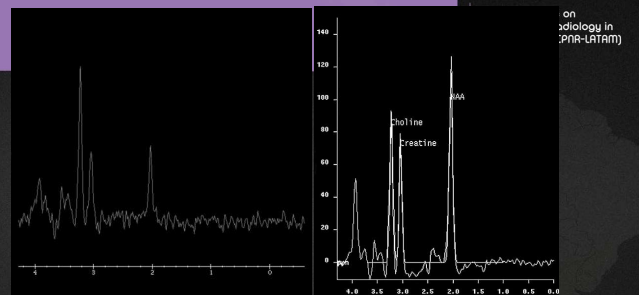
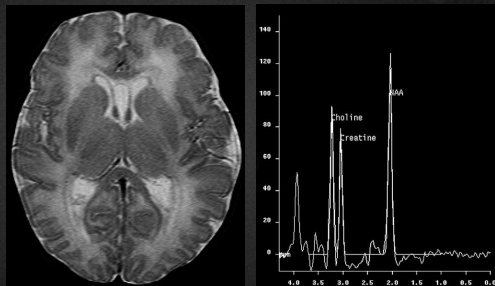
- ▣ Peaks change according to age and location of ROI (GW/MM)
- ▣ In focal lesions, → compare with the contralateral side
- ▣ Diffuse disease → compared to the normal value for age
- ▣ NAA & Cr↑, Cho y ml ↓ with age during infancy

Some examples

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8-day-old with hypotonia

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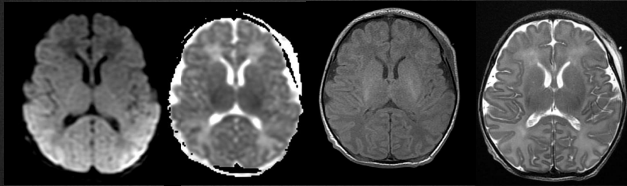


Canavan disease:

- Spongiform leukoencephalopathy, AR (def. of aspartoacylase)
- Normal T2 axial
- MRS: elevated NAA peak

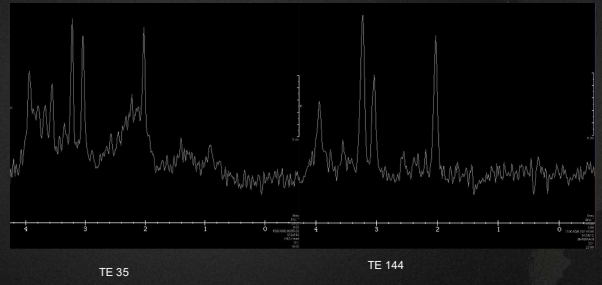
A 15-day-old term male was admitted with acute encephalopathy

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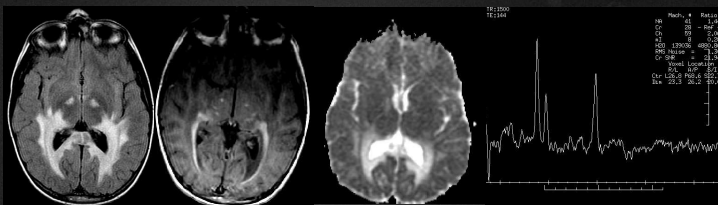
75 Mb duplication on the short arm of chromosome 9 (9p24.1)

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Adrenoleukodystrophy

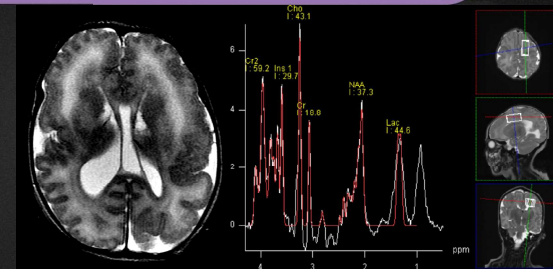
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Peroxisomal disorder, deficiency of acyl-CoA synthetase, X-linked AR
Abnormal signal in Deep WM occipital lobes, CC & PLIC
Presence of lactate peak

Zellweger Sd

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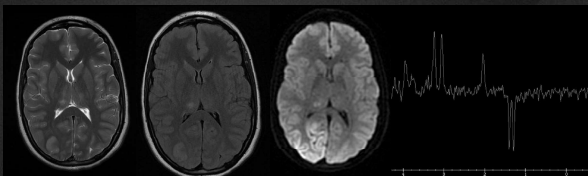


Peroxisomal dysfunction
Bilateral frontal PMG
Lipids on MRS

Phelan, Pediatric Radiol 2008

Mitochondrial Encephalopathy with lactate acidosis and ischemia (MELAS)

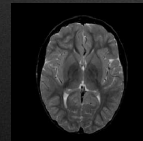
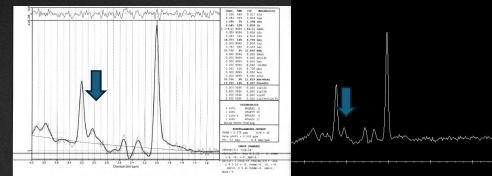
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- Basal ganglia calcification
- Diffusion restriction in occipital lobe → metabolic ischemia
- Lactate peaks

Creatinine deficiency

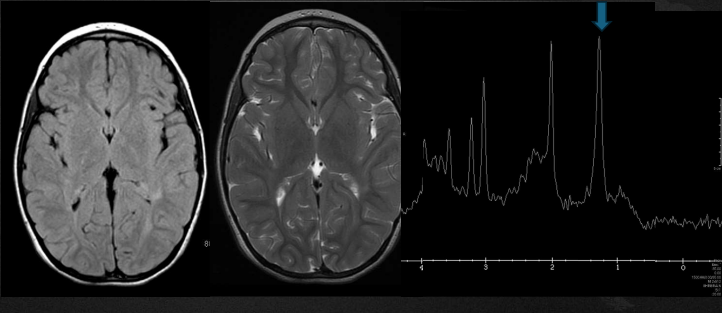
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- GAMT & AGAT deficiency
- Treated with oral creatine monohydrate
- Developmental delay, muscular hypotonia, extrapyramidal movements & epilepsy

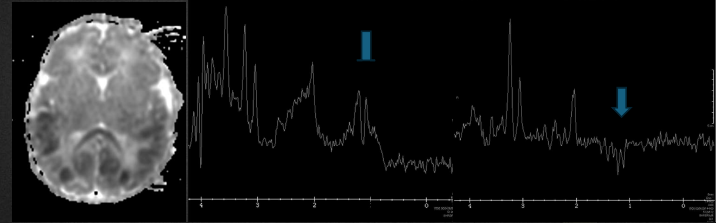
DDHD2 gene mutation
Lip accumulation on MRS

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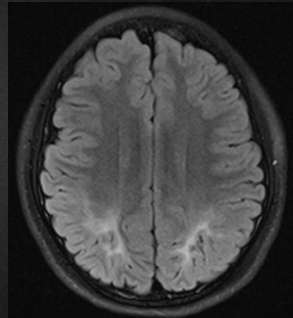
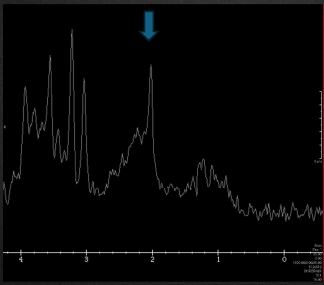
Neonate with hypoglycemia
MRS LCSO

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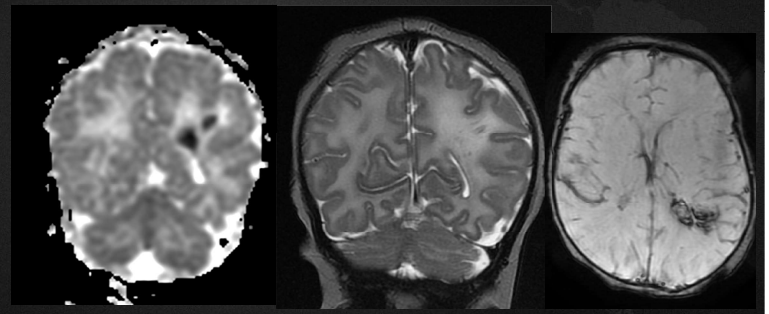
Follow up at 8 years.
MRS LBG

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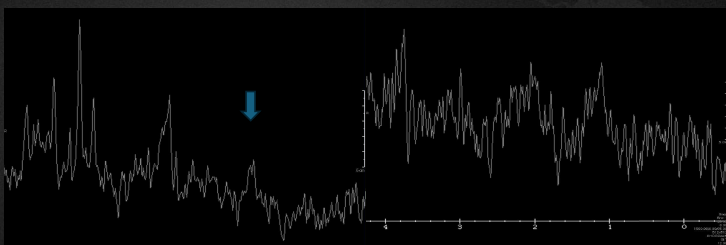
Neonate admitted for hyperinsulinism, severe
hypoglycemia, and encephalopathy.

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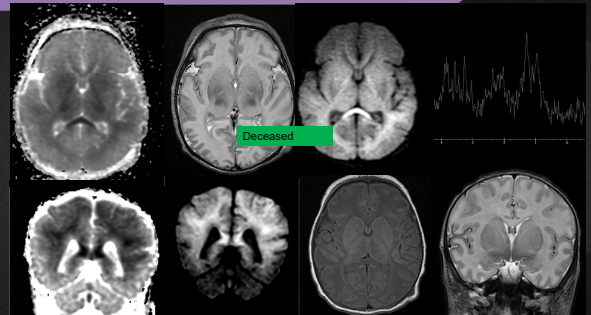
MRS in RCSO and LCSO

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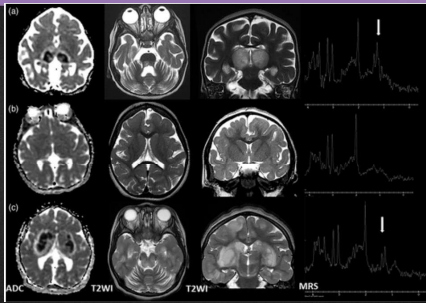
HIE, Global(near total pattern)

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RNU4ATAC in a child with recurrent necrotizing encephalitis

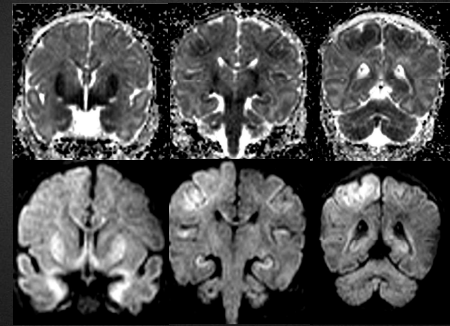
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McMillan H, Davila J, Osmond M, et al. Am J Med Genet A

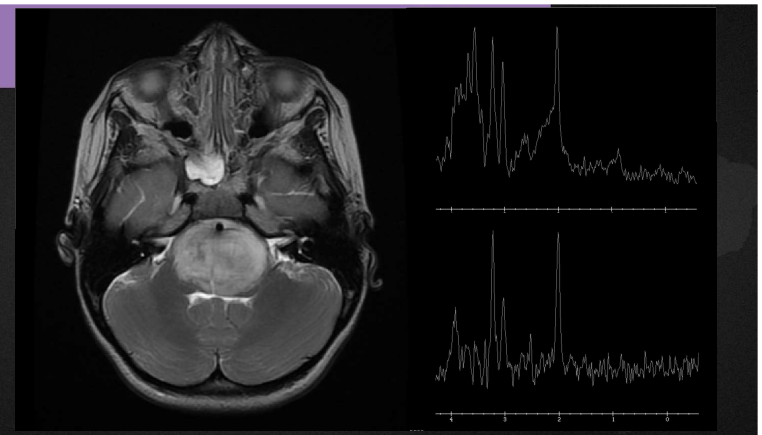
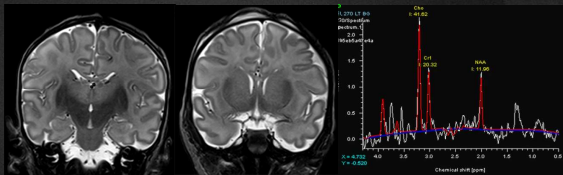
Neonate admitted for HIE and neonatal seizures

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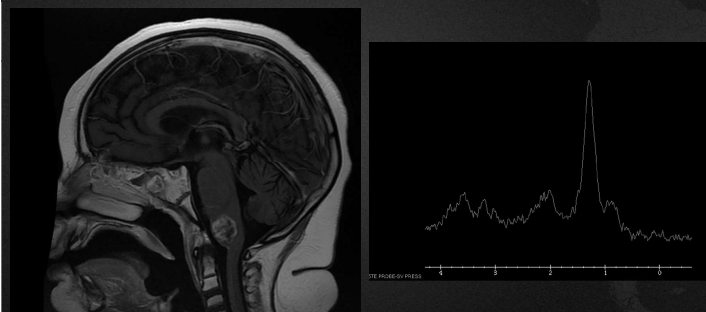
Leigh Sd due to MORC2

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After RT

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Summary

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- Be aware of the acquisition technical details when requesting MRS (TE/ Magnet field/ age/ clinical context)
- Be aware of the artifacts and contamination before interpreting MRS
- Lactate is a non-specific marker
- MRS generally complements conventional imaging findings and should be interpreted in the proper clinical context

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Idealização:



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Organização:

