Fetal brain texture analysis by Automatic Quantitative MRI in SGA fetuses and its predictive value.

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FETAL PROGRAMMING

Alterations in the feto-placental circulation

- O2
- glucose
- amino acids

Developmental diseases that are determined from fetal life due to intrauterine adverse environments

EARLY IUGR
Severe IUGR
GA<34w
Severe placental insufficiency
High morbimortality

LATE IUGR
Not-severe IUGR
GA >34w
Moderate placental insufficiency
Low mortality; Moderate morbidity
LATE IUGR
LATE IUGR

BRAIN STRUCTURE
ABNORMAL?

BRAIN FUNCTION
ABNORMAL?
LATE IUGR

BRAIN STRUCTURE ABNORMAL?

BRAIN FUNCTION ABNORMAL?
• 102 term SGAs vs 100 AGAs neonates: NBAS test

*Figueras 2009, Pediatrics*

- Proportion of SGAs that present an abnormal neurobehavior.

• 112 term SGAs vs 111 AGAs: Bayley III test

*Savchev 2013, UOG*

- Term-SGA born infants at 2yrs show neurological deficits

*Arcangeli UOG 2010*
LATE IUGR

BRAIN STRUCTURE ABNORMAL?

BRAIN FUNCTION ABNORMAL

Brain MRI
Fetal brain MRI

Quantitative imaging biomarkers

ANATOMIC FETAL MRI

DTI. Tractography. Connectomics
- Kaspriant Neuroimage 2008
- Studhome. Int J Dev Neurosc 2013

MR Spectroscopy
- Story AJOG 2013

Resting state
- Schöpf UOG 2012

Texture analysis
- SanzCortes Fet Diagn Ther PLOS One 2013

Cortical development
- Egaña-Ugrinovic AJOG 2013
- Habas Cereb Cortex 2012

Cortical asymmetry
- Kasprian Cereb Cortex 2010

Volumetry
- Studholme IntJ Dev Neurosc. 2013
SPECTROSCOPY

Sanz-Cortes UOG 2010
Sanz-Cortes Under review AJOG 2014

BRAIN METABOLISM

*GLM comparison of each group vs AGA adjusting for maternal smoking, GA at MRI

SGAs differences in brain metabolism
SGAs: Differences in microstructure. More immature pattern.
SGA fetuses show larger cerebellar biometries which are related with neurobehavior.

Sanz-Cortes et al. AJOG 2013.

SGA fetuses show differences in brain sulcation pattern, especially in the insula.


CORTICAL DEVELOPMENT, CEREBELLUM AND BRAIN STEM
Texture Analysis detects WM changes in subclinical stages of PVL in preterm neonates. Tenorio JUM 2011

44 preterm neonates (GA at birth 29 w)

Transcranial US:
1 week after birth

Sensitivity 100% and accuracy 97%

14-31 days: PVL/ no PVL

Normal CrUS profile

PVL CrUS profile
Texture Analysis detects differences in lung texture that predicts respiratory morbidity

<table>
<thead>
<tr>
<th>Gestational age at scan</th>
<th>28-39 w</th>
<th>28.0-33.6w</th>
<th>34.0-39.0w</th>
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</thead>
<tbody>
<tr>
<td>Sample size</td>
<td>144</td>
<td>38</td>
<td>106</td>
</tr>
<tr>
<td>Neonatal respiratory morbidity</td>
<td>29 (20.1%)</td>
<td>21 (55.3%)</td>
<td>8 (7.5%)</td>
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<tr>
<td>Accuracy</td>
<td>86.6%</td>
<td>92.1%</td>
<td>84.9%</td>
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<tr>
<td>Sensitivity</td>
<td>86.2%</td>
<td>90.5%</td>
<td>75%</td>
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<tr>
<td>Specificity</td>
<td>86.9%</td>
<td>94.1%</td>
<td>85.7%</td>
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<table>
<thead>
<tr>
<th></th>
<th>Sensitivity</th>
<th>Specificity</th>
<th>PPV</th>
<th>NPV</th>
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<tr>
<td>L/S Ratio</td>
<td>72%</td>
<td>84%</td>
<td>37%</td>
<td>95%</td>
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<tr>
<td>PG</td>
<td>88%</td>
<td>65%</td>
<td>24%</td>
<td>97%</td>
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<tr>
<td>LBC</td>
<td>88%</td>
<td>66%</td>
<td>19%</td>
<td>98%</td>
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<tr>
<td>quantusFLM²</td>
<td>86.2%</td>
<td>86.9%</td>
<td>62.5%</td>
<td>96.2%</td>
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</table>
Texture analysis showed brain differences in SGA fetuses that increased in those that were VD.
LATE IUGR

BRAIN STRUCTURE ABNORMAL?

CAN WE PREDICT??

Brain MRI

BRAIN FUNCTION ABNORMAL
Automatic Quantitative MRI Texture Analysis in small-for-gestational-Age fetuses discriminates abnormal neonatal neurobehavior *Sanz et al. PLOS One 2013.*

91 SGA fetuses

Fetal MRI

37 w GA. Anatomical acquisition in 3 planes

Delineation 5 ROIS

FRONTAL LOBE

MESENCEPHALON

BBGG

CEREBELLUM

NBAS test

Neonatal neurobehavior: 42 weeks.

42 Cases

>1 area<5th centile

49 Controls

All areas >5th centile
Textural feature selection

Ability of textural features to predict neonatal neurobehavioral performance.
Accuracies to predict abnormal neurobehavior based on brain TA:

- **Frontal** 95.1%
- **BBGG** 95.5%
- **Mesencephalon** 93.1%
- **Cerebellum** 83.3%

GLM adjusting for smoker, BMI, age at NBAS, days of adaptation.
1- A proportion of SGA fetuses show signs of placental insufficiency and abnormal neurodevelopment.

2- Current challenges is to identify which SGA fetuses will have a poor neurodevelopmental outcome.

3- SGA fetuses present signs of abnormal brain metabolism and microstructure.

4- Texture analysis detects changes in brain microstructure of SGA fetuses.

5- Changes detected by Texture Analysis can predict an abnormal neurobehavior during neonatal period.
THANK YOU FOR YOUR ATTENTION

www.medicinafetalbarcelona.org