Imaging the Premature Brain- New Knowledge

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No disclosure
Imaging modalities

- Skull X-ray
- Computer Tomography
- Cerebral Ultrasonography (CUS)
- Magnetic Resonance Imaging (MRI)
Purpose of imaging

- Emergency
- Prognostics
Purpose of imaging

- Emergency
- « A question of life or death »
- Severe injury vs Mild injury
- Life support strategy
CUS as an Emergency tool

- Utility
  - Available 24-7
  - Quick
  - User-dependent

- Information
  - Hemorrhage (GMH-IVH)
  - Malformation
  - Hypoxic-Ischemic Injury

GA 24w. Day 2
MRI as a Emergency tool

- Utility
  - MRI at NICU
  - MRI compatible incubator
  - Daytime / weekdays
  - Time consuming
  - Lack of experience

- Information
  - Hemorrhage
  - Anatomy
  - Signal abnormalities
  - Restricted diffusion
In the Emergency setting:

CUS no 1!
Purpose of imaging

- Prognostics

To use Imaging as a predictor of outcome
WARNING

“The practice of routine early neonatal neuroimaging to predict Neurodevelopmental Impairment (NDI) in premature infants is problematic as a plurality of factors influence ultimate neurologic outcomes.”

Mann P.C, Woodrum D.E, Wilfond B.S,
WARNING

“We encourage neonatal practitioners to **reconsider whether** the perceived screening benefits are valid and the prediction of NDI (Neurodevelopmental Impairment) definitive.”

Prognosis - Outcome

- Motor function?
- Cognitive?
- Behavioral?
- Neuropsychiatric?
- Quality of Life?
Prognosis

“Dilemmas in the Measurement of Developmental Outcomes of Preterm Children”

Maureen Hack, Division of Neonatology, Rainbow Babies & Children’s Hospital, Cleveland, Ohio, USA

Prognosis & Strategy

- **GMH IVH**
  Germinal Matrix Hemorrhage- Intraventricular Hemorrhage

- **DESHI**
  Diffuse Excessive High Signal Intensities (DESHI)

- **CUS vs. MRI**
GMH IVH grading

Papile’s classification:
Grade I: GMH / subependymal hemorrhage
Grad II: IVH
Grade III: IVH with ventricular dilatation
Grade IV: IVH with ventricular dilatation and parenchymal extension

GMH IVH- “long ago”

- Grade 1 and 2: no effect on outcome
- Grade 3 and 4: major effect on outcome
GMH IVH – “10 years ago”

- Extremely low birth weight infants with grades I-II IVH have poorer neurodevelopmental outcomes at 20 months' corrected age than infants with normal cranial ultrasound.

GMH IVH- “Nowadays”

- Grade I–II IVH, even with no documented white matter injury or other late ultrasound abnormalities, is associated with adverse neurodevelopmental outcomes in extremely preterm infants.¹

- ELBW infants with bilateral compared to those with unilateral grade IV IVH had worse neurodevelopmental outcomes. Infants with grades I–III IVH had similar outcomes whether they had unilateral or bilateral IVH ²


Magnetic Resonance Imaging

DESHI

0 Association between DESHI and outcome ??
Magnetic Resonance Imaging

DESHI

- Although DEHSI may represent disturbances in white matter structure, as illustrated by its relationship to altered ADC and FA values, there is no relationship to short-term neurodevelopment outcome.¹

- No association between the presence of diffuse excessive high signal intensities and CP or with infant/toddler development (Bayler scale).²


Magnetic Resonance Imaging

DESHI

- Although the incidence of DEHSI was high (75%) in preterm infants at near-term-equivalent age MR imaging, DEHSI was not predictive of following adverse outcomes.¹
- Preterm children with DEHSI have similar neuro-developmental outcome to those with normal brain MR²


CUS vs MRI

- CUS is a good screening tool to detect serious brain injury resulting in motor handicaps.¹

- CUS is more sensitive for recognizing acute intraventricular hemorrhage, perforator stroke and sinovenous thrombosis, but less for small cerebellar haemorrhages²

¹ Limitations of routine neuroimaging in predicting outcomes of preterm infants. Whyte HE, Blaser S. Neuroradiology. 2013 Sep;55 Suppl 2:3-11

CUS vs MRI

- Advanced serial CUS seems highly effective in diagnosing preterm brain injury, but may miss cerebellar abnormalities.
- MRI is necessary to accurately predict the outcomes of preterm infants, especially cognitive delays.


Limitations of routine neuroimaging in predicting outcomes of preterm infants. Whyte HE, Blaser S. Neuroradiology. 2013 Sep;55 Suppl 2:3-11
CUS vs MRI

- MRI is more sensitive than CUS, especially useful in the identification of small intraventricular hemorrhage; cerebellar hemorrhage, punctate lesion in the WM and cerebellum and diffuse, non-cystic WM injury \(^1\)

- MRI is superior to CUS for the definition of patterns of both WM and GM maturation and injury and therefore has the potential to provide prognostic information on the neurodevelopmental outcomes of the preterm population \(^2\)


CUS vs MRI

- Near-term CUS and MRI abnormalities were associated with adverse 18- to 22-month outcomes, independent of early CUS and other factors.¹
- Neonatal MRI provides useful information, but this information needs to be treated with caution when predicting outcome.²
- Further research is needed to define the role of MRI in neonatal care.³

³ Magnetic resonance imaging of the brain at term equivalent age in extremely premature neonates: to scan or not to scan? Smyser CD et al J Paediatr Child Health. 2012 Sep;48(9):794-800.
CUS vs MRI

- Recent studies have found CUS scanning and MRI abnormalities to be equally predictive of cerebral palsy and early childhood cognitive outcomes in preterm infants.¹

- CUS and MRI are complementary modalities.²,³

Strategies

- Serial CUS + CUS at term
- Serial CUS + CUS & MRI at term
- Serial CUS + early MRI
- Serial CUS + early MRI and MRI at term
Conclusion

0 Bedside CUS is still modality of choice in a emergency setting

0 MRI at term adds valuable prognostic information but its role has to be better defined
Conclusion

- CUS and MRI are complementary modalities

- Serial CUS and imaging at term (CUS/MRI) seems like a promising strategy
Thank you for your attention!
Advanced MRI

- Diffusion-MRI is an effective tool for investigating preterm white matter injury.\(^1\)
- Diffusion-weighted, diffusion tensor, and susceptibility weighted imaging may improve recognition and prediction of outcome \(^2\)


Purpose of imaging

Research

- Development of the brain
- In utero vs ex-utero development
- Influence of treatment and life support in the preterm period