Fetal Imaging of Twins
Twin to Twin Transfusion Syndrome

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No disclosures

You go out first. Signal me if it's safe!!
Overview

- Quick review of placental appearance in TTTS
- Discuss CNS involvement in TTTS
- Review cases
Background: TTTS

- Serious complication of MC/DA twin pregnancies
  - Result of unbalanced placental A-V, A-A, V-V anastomoses
- If untreated, high risk of mortality (80-100%)
- Markedly limited imaging evaluation pre-laser
Placental vessels

Fetoscope
Field of View
~ 3 mm

Selective Fetoscopic Laser Photocoagulation
Placental surface vessels

- Many centers trying to assess placental equator and vascularity by imaging
- Using 3D US and MRI: fusion of images
- Post processing techniques using software
- We are still long time away from reaching this

Edema of the cotyledons best seen on bright blood technique
Enlargement of the chorionic villi with edema-fluid and abundant stroma

Placental hydrops
MRI cord insertion

11-12 o’clock DONOR
At 1 o’clock Recipient
Double Barrel umbilical cord insertion
Fetuses who survive are at risk of severe neurologic, cardiac, and developmental disorders

- Cerebral Palsy >20%

Selective Fetoscopic Laser Photocoagulation of vascular anastomoses improves survival and neurologic outcomes

- Despite SFLP, risk of cerebral injury and neurodevelopmental impairment 6-25%

Incidence of prenatal CNS abnormalities

- Varies widely 6-64%: most used postnatal US at 24-48 hours of life

- Merhar et al:
  - Incidence: 23% had brain injury on fetal MRI and 68% had brain injury seen on postnatal MRI (only 18% seen in postnatal US)
  - Quintero staging was only predictor of postnatal brain injury (GA and BW)

CHCO Experience

- 4 year time period

- Incidence of brain abnormality by MRI 17%

- No predictor of brain anomaly based on degree of cardiac dysfunction or Doppler abnormality

Erhrig, J. et al. AJOG 2015
…We found that the Quintero stage at presentation was the only statistically significant predictor for total brain injury…

- *Cincinnati* modification better predicted hemorrhagic injury in recipients

- *Quintero* staging better predicted hemorrhagic injury in donors

Outcome - Neurodevelopment

Evaluation of long-term neurodevelopment in twin-twin transfusion syndrome after laser therapy

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• Concluded that TTTS is associated with 13.5% increased risk of abnormal neurological development even after laser surgery
Mechanism of Injury

- **Antenatal** neurologic injury: related to alterations in blood flow
  - Donor twin brain injury mechanism:
    - hypovolemia-hypoxia and ischemia
  - Recipient brain injury mechanism:
    - hypervolemia / hemorrhage
- **Postnatal** neurologic injury: related to prematurity
TTTS: CNS Imaging

- US first in evaluating the fetuses: Does not predict later neurodevelopmental outcomes as well as MRI

- MRI Advantage: better visualization of intracranial structures not well seen by ultrasound

- The most common intracranial abnormality is ventriculomegaly (D > R)

# Fetal and postnatal brain MRI in premature infants with twin–twin transfusion syndrome

<table>
<thead>
<tr>
<th>Postnatal brain injury</th>
<th>Donor (n = 11)</th>
<th>Recipient (n = 11)</th>
<th>Total (n = 22)</th>
<th>Total %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Intraventricular/periventricular hemorrhage</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>32%</td>
</tr>
<tr>
<td>White-matter volume loss</td>
<td>4</td>
<td>3</td>
<td>7</td>
<td>32%</td>
</tr>
<tr>
<td>Ventriculomegaly</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Unilateral</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>9%</td>
</tr>
<tr>
<td>Bilateral</td>
<td>2</td>
<td>1</td>
<td>3</td>
<td>14%</td>
</tr>
<tr>
<td>Cerebral volume loss</td>
<td>3</td>
<td>2</td>
<td>5</td>
<td>23%</td>
</tr>
<tr>
<td>Periventricular white-matter injury</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>18%</td>
</tr>
<tr>
<td>Migrational anomalies (cleft with gray-matter heterotopia)</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>5%</td>
</tr>
<tr>
<td>Cerebellar injury</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td>9%</td>
</tr>
</tbody>
</table>
Timing the lesions
When do the brain injuries occur?

- In perinatal HIHI ADC signal decrease within hrs of onset and nadir 2-3 days. Pseudo-normalizing at 4-8 days.
- In fetuses: decreased ADC can last for 3 wks.
- Determining the timing of lesions using prenatal or early postnatal US may not be accurate.
- Be cautious in interpreting diffusion abn in the fetal brain when attempting to determine the timing of injury.

Merhar SL et al J Perinatology (2013) 33, 112-118
US findings

• TTTS findings seen with US:
  - Poly/oligohydramnios
  - Bladder/no bladder
  - Cardiomegaly
  - Lack of motion
  - Hydrops
  - No specific findings of the CNS
MRI Findings: Donor

- Cerebral malformations (Holoprosencephaly, cortical malformations)
- Enlarged cerebral venous sinuses (50%)
- Infarct
- Decreased cerebral mantel thickness and brain growth
- Smaller cerebellum
- Decreased brain/cerebellum thought to be due to ischemia/hypoperfusion

Kline-Fath et al. 2007; Taui 2012
“TTTS specifically impacts development of the cerebral mantle in donor twins which can’t be explained by the overall growth restriction”
22 wks 3 d

Donor

Recipient

Reflects venous hypertension in the cerebral circulation
22 wks 3 d Donor
Donor

Courtesy of Beth Kline-Fathe, MD
MRI Findings: Recipient

- Cerebral ischemia
- Intraventricular or GM hemorrhage
- Enlarged cerebral venous sinuses (13%)
- Rapid growth of the cerebellum surpassing that of the singleton
- Lung lesions: CPAM

Kline-Fath et al. 2007; Tai 2012
Normal twin with normal CSP
Recipient
Donor
Recipient
TTTS post FSLP
No Ix before laser

21 w 3 d
Donor
Donor
6 mo lx
Abnormal appearance of the umbilical cord – Recipient T, particularly in the umbilical vein, query thrombosis

Large germinal matrix grade 4 hemorrhage in the recipient's brain

High suspicion for imminent fetal demise
Abnormal appearance of the umbilical cord – Recipient T, particularly in the umbilical vein, query thrombosis

Large Germinal matrix grade 4 hemorrhage in the recipient's brain

High suspicion for imminent fetal demise
UA with absent end-diastolic flow

UV with reversed flow

DV with reversed a-wave
Is not all about the brain

Recipient
Fetal Demise

MRI signs of fetal death

- Decreased signal:
  - Liver
  - Kidneys
  - Heart and cord on bright blood technique images
  - Brain hemorrhage best seen on EPI images

- Decreased motion
Donor

dark liver

Recipient

comparison liver
Fetal demise
Summary

- MRI provides valuable CNS information in cases of TTTS
- Along with Ob US and echo, fetal MRI helps with fetal surgery and perinatal planning
That nearly scared me to death!
I have a full bladder and a weak heart, you know...
References

4. Mari et al 2001 ; Tarui et at
THANK YOU

Questions?