Monochorionic Twins: Double Trouble

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Objectives

• Define the biology of twining
• Explain the importance of ultrasound in determining chorionicity and amnionicity of twin pregnancy
• Describe the complications associated with monochorionic gestation
• Recognize the development of twin-twin transfusion syndrome (TTTS)
• Identify the antenatal management of monochorionic gestation
Incidence

• Twins = 96% of multiple births in the US
• Dizygotic twins [69%] more common than monozygotic twins [31%]
• Incidence of monozygotic twins relatively stable worldwide [3-5 per 1,000 births]
• Assisted reproductive technology
  – High incidence of monochorionic twins
  – 3.2 % vs background risk of 0.4 %

The Biology of Twinning

• Zygosity
  – Monozygotic: Division of ONE fertilized ova
  – Dizygotic: TWO distinct fertilized ova

• Amnionicity & chorionicity
  – Dizygotic: ALWAYS have separate chorion and amnion
  – Monozygotic: Determined by timing of fertilized ovum division

• Placentation
  – One placenta = Monochorionic Monozygotic
  – Two placentas = Dichorionic but not necessarily dizygotic
Zygosity = Genetic Makeup

• Dizygotic – ovulation & fertilization of 2 oocytes
  – 67-80% of all twin births
  – Always results in diamniotic, dichorionic placentation
  – Usually 2 separate placentas

• Monozygotic - ovulation and fertilization of a single oocyte, with subsequent division of the zygote
  – 20-33% of all twin births
  – Timing of zygote division determines placentation although factors responsible for timing of egg division are not known
## Timing of Cleavage

<table>
<thead>
<tr>
<th>DAY</th>
<th>CHORIONICITY</th>
<th>PLACENTATION</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-3</td>
<td>Dichorionic Diamniotic</td>
<td>2 SEPARATE or FUSED</td>
</tr>
<tr>
<td>4-8</td>
<td>Monochorionic Diamniotic</td>
<td>ONE</td>
</tr>
<tr>
<td>9-12</td>
<td>Monochorionic Monoamniotic</td>
<td>ONE</td>
</tr>
<tr>
<td>13-15</td>
<td>CONJOINED</td>
<td>ONE</td>
</tr>
<tr>
<td>&gt;15</td>
<td>SINGLETONE</td>
<td>ONE</td>
</tr>
</tbody>
</table>
Amnionicity Chorionicity & Zygosity

**Dichorionic**
- Placenta
- Amnion
- Chorion
- Dichorionic with separate placentas
- Dichorionic with fused placentas

**Monochorionic**
- Placenta
- Amnion
- Chorion
- Diamniotic monochorionic
- Monoamniotic monochorionic

(Either DZ or MZ)  (All are MZ)
Monozygotic Twins

• Dichorionic Diamniotic: 15-25%

• Monochorionic Diamniotic: 75%

• Monochorionic Monoamniotic: 1-2%

• Conjoined: Rare
Ultrasound

- **Can**: determine number of amnions and chorions

- **Cannot**: determine zygosity
  - Not all dichorionic diamniotic twins are fraternal unless there is gender discordance
Importance of Ultrasound

• Description of the number of:
  – Amnions
  – Chorions
  – Fetuses

• Guides management of the pregnancy
  – Prognosis
  – Counseling
  – Selective reduction
  – Follow up
Significance of Amnionicity & Chorionicity

- Monochorionicity more important than zygosity
  - 10 to 15% of mono/di twins will develop twin-twin transfusion syndrome
  - Monochorionic twins are at increased risk of neurologic morbidity, discordant birth weight, and co-twin in utero death
  - Selective reduction of one twin:
    - only an option for dichorionic/diamniotic twins
    - selective termination can result in death of co-twin
Monochorionic vs Dichorionic

- Fetal loss rate prior to 24 weeks
  - 12.2% vs 1.8%
- Perinatal mortality
  - 28% vs 1.6%
- Deliveries prior to 32 weeks
  - 9.2% vs 5.5%
- Birth weights < 5th percentile for twins
  - 7.5% vs 1.7%

Twin Peak Sign

• Lambda Sign
• Delta Sign

• Triangular portion of tissue with the same echogenicity as placenta

• Extends beyond the chorionic surface of the placenta
Twin Peak Sign

- Between 10-14 weeks
- Indicates a dichorionic twin pregnancy
- Absence suggests a monochorionic twin pregnancy
- At 16-20 weeks it is still diagnostic of a dichorionic twin pregnancy
- Harder to identify as the pregnancy progresses
- Absence not indicative of monochorionic twin pregnancy
  - Does not exclude dizygosity
Twin Peak Sign
Placentation

• 2 distinct placentas
  – Usually dichorionic
  – 3% of monochorionic placentas bilobed [succenturiate] and may appear as 2 distinct placental lobes
  – About 50% of dichorionic placentas are fused
  – Cannot determine chorionicity in all cases

Dichorionic Vs Monochorionic
Monochorionic-Diamniotic Vs Monoamniotic

- Sac with 2 or more fetuses
- Embryos in close proximity: wait until at least 6-7 weeks
- Reassess at 9-10 weeks
  - Amnion seen separate from the embryo
  - Multiple amniotic sacs within a single chorion = diamniotic monochorionic
  - One sac = Monoamniotic
    - Number of yolk sacs = number of amnions
    - In 15% of monochorionic/diamniotic twins only single yolk sac identified

First trimester

**Monochorionic**

**Dichorionic**
First trimester

Dichorionic                                Monochorionic                    Monoamniotic
Membrane Artifacts

- Mistaking chorion-amnion separation for inter-twin membrane
- Draping of membranes
- Fetal movement
- Appearance change with advancing gestation.
- Synechiae
- Mistaking umbilical cord for a membrane
Membrane Artifacts

- Chorion -amnion separation
- Umbilical cord
- Synechiae
Monoamniotic twins

- Higher risk for cord entanglement and accidents
- Usually admit at viability for corticosteroids and continuous monitoring and intervention as clinically indicated
- Delivery ~32 weeks
Monochorionic Twins
Monochorionic Twins

T Sign
Fetal Biometry in Monochorionic Twins

• Chromosomal make up is the same
• Placentation is similar
• Vascular communications do not characteristically produce an imbalance in the first trimester

• If there is discrepancy in crown-rump length
  – Use the larger for gestational age assessment

Fetal Growth in Twins

• Same as singletons during 1st & 2nd trimesters
• Generally follow singleton ultrasound growth charts
• Likely slower growth during 3rd trimester after 30-32 weeks
• Singleton growth curves best predictor of adverse outcome


Monochorionicity: Specific pregnancy complications

• Incidence of congenital anomalies 3-5 fold higher
  – Concordance rate is about 20 percent
• Increased incidence of congenital heart defects


Monochorionicity: Specific pregnancy complications

- Shared placental mass and fetoplacental circulation
  - Selective intrauterine growth restriction
  - Twin anemia-polycythemia sequence [TAPS]
  - Twin reversed arterial perfusion [TRAP]
  - Twin-twin transfusion syndrome [TTTS]
    - 10-15%
    - Oligohydramnios-polyhydramnios sequence

- Increased risk of neurologic morbidity and perinatal mortality
- Increased stillbirth and neonatal death rates

Growth Discordance

- May be present by 20 weeks
- Placental vascular anastomoses
  - Imbalance of placental flow between the fetuses
- Abnormal cord insertion
  - Marginal
  - Velamentous
- IUGR in preterm discordant twins
  - associated with 7.7 fold increase in major neonatal morbidity

Abnormal cord insertion

Marginal Insertion

Velamentous Insertion
Twin anemia-polycythemia sequence [TAPS]

• Atypical chronic form of TTTS
  – Spontaneous in 3-6% of uncomplicated third trimester monochorionic/diamniotic twins
  – Most diagnosed in the late second or early third trimester
  – Inter-twin hemoglobin difference
  – No oligohydramnios-polyhydramnios sequence
  – Incidence after laser therapy 2-13%


Twin anemia-polycythemia sequence [TAPS]

- Middle cerebral artery peak systolic velocity [MCA-PSV]
  - > 1.5 multiples of the median [MoM] in the donor twin for gestational age
  - < 0.8 MoM in the recipient twin
- Growth discordance
- Fetal and placental thromboses & hydrops in the anemic twin
- Postnatal: inter-twin hemoglobin difference of ≥ 8.0g/dL and inter-twin reticulocyte ratio >1.7

Middle cerebral artery peak systolic velocity
Monochorionicity: Specific pregnancy complications

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Twin reversed arterial perfusion [TRAP]

- Incidence 1% of monochorionic twins
- Twin with absent or non functioning heart [acardiac] perfused by co-twin [pump] via placental arterial anastomoses
  - Poorly developed heart, upper body and head
  - Doppler shows arterial blood flowing towards rather than away from the acardiac twin
  - Pump twin [the normal one] at risk for heart failure
Twin reversed arterial perfusion [TRAP]
Twin reversed arterial perfusion [TRAP]

• Management
  • In utero therapy 18-27 weeks
    - Weekly ultrasound to assess for signs of fetal hydrops
    - Doppler of the umbilical artery, vein and ductus venosus
    - Increase to twice weekly if evidence of prehydrops
    - Corticosteroids 24-34 weeks
Monochorionicity: Specific pregnancy complications

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Twin-Twin Transfusion Syndrome
Unbalanced Vascular Anastomoses

• Arterio-venous
• Veno-arterial
  • Feeder vessels on surface
  • Descend into common cotyledon capillary network & anastomose
• Arterio-arterial
• Veno-venous
  • Exclusively on surface
  • Bidirectional
  • Driven by hydrostatic pressure
Unbalanced Vascular Anastomoses

• Found in virtually all monochorionic twins
  – Unbalanced connections = TTTS
  – Balanced connections ≠ TTTS
  – Arterioarterial anastomoses are protective

  – Only 10-15% of monochorionic twin develop TTTS
  – Can develop as early as 16 weeks
Pathophysiology: Donor

- Imbalance in placental vascular anastomoses
- Hypovolemia
- Vasoactive mediators [vasopressin] Renin Angiotensin system upregulated
- Oligohydramnios
Pathophysiology: Recipient

Hypervolemia

Stretching of Cardiac Atria

Release of atrial natriuretic peptide and brain natriuretic peptide

Fetal polyuria

Polyhydramnios
Pathophysiology

1. Donor deterioration
2. Elevated renin and angiotensin
3. Pass though placental anastomoses to recipient
4. Hypertension
5. Decreased urine output
6. Resolution of polyhydramnios
Pathophysiology: Recipient

- Cardiac hypertrophy & dysfunction
- Right sided dysfunction > left–sided dysfunction
- Depressed myocardial contractility
- Tricuspid regurgitation & reversed a-wave of the ductus venosus
# Quintero Staging

<table>
<thead>
<tr>
<th>Gestational Age</th>
<th>DVP Recipient</th>
<th>DVP Donor</th>
</tr>
</thead>
<tbody>
<tr>
<td>&lt; 20 weeks</td>
<td>≥ 8 cm</td>
<td>&lt; 2 cm</td>
</tr>
<tr>
<td>≥ 20 weeks</td>
<td>≥ 10 cm</td>
<td>&lt; 2 cm</td>
</tr>
</tbody>
</table>

**PLUS**

<table>
<thead>
<tr>
<th>Bladder filling in donor</th>
<th>No bladder filling in donor</th>
<th>Abnormal umbilical artery Doppler [AEDF/REDF], Abnormal venous Doppler [reversed a-wave in DV or pulsatile flow in UV]</th>
<th>HYDROPS</th>
<th>IUFD</th>
</tr>
</thead>
<tbody>
<tr>
<td>Stage I</td>
<td>Stage II</td>
<td>Stage III</td>
<td>Stage IV</td>
<td>Stage V</td>
</tr>
</tbody>
</table>
Umbilical artery Doppler

Normal

Absent end diastolic flow (AEDF)

Reversed end diastolic flow (REDF)
Ductus Venosus

Normal

Reversed a-wave
Umbilical vein Doppler

Normal

Pulsatile Flow
Hydrops
Quintero Staging

• One method of standardization
  – Cincinnati modification of Quintero Staging
  – Cardiovascular Score [Children’s Hospital of Philadelphia: CHOP Score]

• Atypical presentations can occur
  – Donor with persistent bladder AND abnormal umbilical Doppler flow
  – Clinical presentation does not always follow orderly progression of stages
    » Can rapidly progress from Stage I-III
    » Regression in as many as 15% Stage I and 60% Stage II

Clinical Case

- AB is a 21 yo G2 P0 AB1 referred for consultation of monochorionic twins at 16w 3d
  - OB Hx: SAB x 1
  - GYN Hx: ovarian cancer [type unknown] s/p oophorectomy & 4 cycles of chemotherapy in 2009; yeast infection
  - PMH: Thyroid disorder: no meds
  - PSH: oophroectomy
  - SH: no tobacco, alcohol or drug use; developmental delay
  - FH: HTN
  - Meds: Prenatal vitamins, Clotrimazole
  - Allergies: None
Clinical Case

• Ultrasound
  – Monochorionic twins
  • A: 167 g [59%] DVP: 6.1 cm [Recipient]
    – + Bladder
    – Normal UA and DV Doppler
    – No UV pulsations
    – Single umbilical artery
    – Marginal cord insertion
  • B: 152 g [37%] DVP: 2.0 cm [Donor]
    – No bladder seen
    – UA and DV [ductus venosus] Doppler normal
    – Weight discordance: 9%
Clinical Case

• Other findings
  – Placenta previa
  – Uterine synechiae vs circumvallate placenta

• Suspected Stage II TTTS
  – Sent to Evergreen for evaluation
Clinical Case

- 17w 2d: Stage 0 bordering on Stage II
  - Normal fluid [DVP] for A & B
  - B with small bladder

Stage II
Clinical Case

- 17w 5d: Stage I
  - A: polyhydramnios
    - Reversed a wave in the DV
  - B: oligohydrarnnios
Clinical Case

– 18w 2d: Stage I
  • A: polyhydramnios
    – Normal Dopplers
    – Velamentous cord insertion
  • B: oligohydramnios
    – Normal Dopplers

– 18w 5d: Stage I [going to Stage II]
  • A: polyhydramnios [DVP: 11]
  • B: oligohydramnios [DVP: 1]
    – Reversed a wave in DV
Clinical Case

– 19w 5d: Stage 0
  • A: polyhydramnios
  • B: low normal fluid [improved]
    – More fluid in bladder than recipient
  • Resolving TTTS or reverse TTTS with the ex donor, now the recipient?
    – Normal Dopplers
    – No evidence of heart strain or abnormal Dopplers in the donor
Important to Remember……

• Atypical presentations can occur
  – Donor with persistent bladder AND abnormal umbilical Doppler flow
  – Clinical presentation does not always follow orderly progression of stages
    » Can rapidly progress from Stage I-III
    » Regression in as many as 15% Stage I and 60% Stage II
TTTS Treatment Options

• Expectant management
• Amnioreduction
• Septostomy
• Cord ligation: selective feticide
• Fetoscopic laser ablation of vascular anastomoses
Fetoscopic laser ablation

- Definitive treatment for Stage II or above
- Between 16-26 weeks gestation
  - FDA investigational device exemption
- Outpatient procedure
  - Local Anesthesia with IV sedation
  - Regional or General
Fetoscopic laser ablation: Complications

- Premature rupture of membranes
- Twin anemia-polycythemia sequence [TAPS]
  - Up to 6 weeks after [follow MCA-PSV]
  - Patent or residual arteriovenous anastomoses between recipient and donor
    - Slow passage of red cells in reverse manner
    - Recipient ➔ Anemic
    - Donor ➔ Plethoric
Fetoscopic laser ablation: Follow Up

- Serial ultrasound at least weekly for 6 weeks
  - MCA-PSV

- Every 2 weeks thereafter
- Normalization of the amniotic fluid by week 5 in donor and by week 8 in the recipient in 95% of cases


Fetoscopic laser ablation: Follow Up

• Monitor fetal growth every 3-4 weeks [especially in donor]
• Twice weekly antenatal testing from 28-30 weeks until delivered
• Corticosteroids: growth discordance or preterm delivery likely
• Delivery for fetal compromise or poor serial growth
  – 32-37 weeks
    • Risk of unexplained fetal demise in late gestation
Twin-Twin Transfusion Syndrome Surveillance

- Thorson
  - Retrospective look at 108 MC pregnancies
    42 with TTTS
    - Peak incidence occurred at 18 0/7-18 6/7 weeks
    - 2/3 were diagnosed before 22 0/7 weeks
    - Screening interval >14 days associated with late Quintero stage at diagnosis (OR 9.45)

Monochorionic Twins: antepartum management

• Ultrasound every two weeks if normal [start at 16 weeks]
  – Maximum vertical pockets
    – Discordant fluid volumes.
    – Two 2 cm pockets with membrane in view
  – Bladder
  – Evidence of hydrops, presence of effusions, ascites
  – Doppler studies as indicated [UA, DV, UV]
  – MCA-PSV for early detection of TAPS
• Fetal echocardiogram ~23 weeks
Twin-Twin Transfusion Syndrome Surveillance

- Clinically determined based on findings and gestational age
- Increase surveillance schedule
  - Weekly [EFW or Fluid pocket discordance]
  - Twice weekly at least until 28-32 weeks
- Admission for in-patient surveillance
- Corticosteroids
- Delivery: Acute or chronic deterioration of one or both fetuses after viability

Death of one twin

• About 5% of twin pregnancies after 20 weeks
  – Vascular anastomoses
  • Severe hypotension, anemia and ischemia in the surviving co-twin
• Morbidity or death
  – Rates of fetal demise 15%
  – Rates of preterm birth 68%
  – Rates of abnormal postnatal cranial imaging 34%
  – Neurodevelopmental impairment 26%
Death of one twin

• Management
  – Fetal assessment suggests impending death of one twin
    • Prompt delivery considered if at viability
  – Demise already diagnosed
    • Conservative management
      – Effects are immediate
      – Intervention to prevent damage to surviving twin are futile
  • 32-34 weeks: corticosteroids & deliver in 48 hours
  • <32 weeks: continue pregnancy
  • Risk of cerebral palsy as high as 20%

Summary

- Monochorionic twins are high risk due to vascular anastomoses
- Important to determine chorionicity early in the pregnancy
- Surveillance protocols designed to assess for development & evolution of TTTS
- TTTS may not follow logical staging progression
- Modify surveillance accordingly
Certificate Requirements

• To obtain a certificate, copy and paste the following link into your browser to access the post test/evaluation form:
  http://www.surveygizmo.com/s3/1440409/WCGRPT1113

• Physicians who successfully complete the post test will receive CME credit. All others, who successfully complete the post test, will receive a certificate of participation.
Bibliography/References


