Using Ultrasound to Manage Twins

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Learning Objectives

After this presentation, the learner will be able to discuss:

- Diagnosis and dating in twin pregnancies
- Sonographic characteristics that distinguish dichorionic from monochorionic twins
- Prenatal ultrasound screening in twins
- Complications unique to monochorionic twins
- Ultrasound surveillance recommendations for twins

Diagnosis and Dating of Twins

- Diagnosis best in the first trimester and dating optimal using crown-rump length
  - 20% of first trimester twin pregnancies result in singleton live births
  - "Vanishing twin" is associated with favorable prognosis of surviving twin if dichorionic

- If discrepancy in dates between the twins, date using the larger twin
  - Avoids missing diagnosis of IUGR

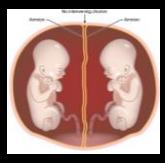
Importance of Pregnancy Dating

- Timing for screening and diagnostic testing
- Accurate interpretation of twin growth
- Scheduling of twin deliveries

Types of Twins

- All dizygotic twins are dichorionic
- All monochorionic twins are monozygotic
- Not all monozygotic twins are monochorionic

2-3 days (28%)



3-8 days (70%)

8-13 days (1%)

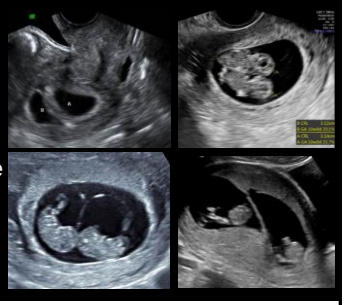
Determination of Chorionicity

- Optimal in first trimester
  - *close to 100% accuracy*
- Incorrect assignment in up to 10% of cases when chorionicity determined in second trimester

Lee et al, 2006
Blumenfeld et al, 2014

Determination of Chorionicity

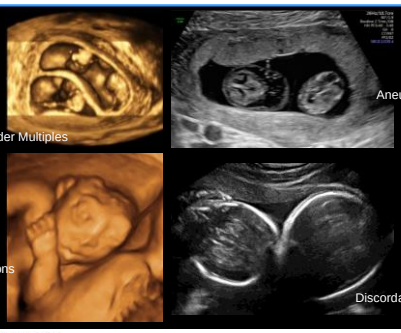
- Gestational sacs
- Amniotic sacs
- Placenta number
- Intertwin membrane
- Gender



Intertwin Membrane

λ sign T sign

Importance of Chorionicity



Higher-Order Multiples

Aneuploidy

Malformations

Discordant Growth

Prenatal Diagnosis

Goals in twin gestations are the SAME as for singletons

- To identify fetal abnormalities that could change a couple's decision to continue a pregnancy or alter obstetric care
- To identify fetuses that might benefit from fetal or early neonatal therapy
- To provide reassurance that twins are developing normally

Graham and Simpson, 2005

The American College of Obstetricians and Gynecologists
WOMEN'S HEALTH CARE PHYSICIANS

Society for Maternal-Fetal Medicine

PRACTICE BULLETIN

CLINICAL MANAGEMENT GUIDELINES FOR OBSTETRICIAN–GYNECOLOGISTS

NUMBER 163, MAY 2016

(Replaces Practice Bulletin Number 77, January 2007)
(See also Practice Bulletin Number 162, *Prenatal Diagnostic Testing for Genetic Disorders*)

Screening for Fetal Aneuploidy

- Aneuploidy screening or diagnostic testing should be discussed and offered to all women early in pregnancy, ideally at the first prenatal visit.
- All women should be offered the option of aneuploidy screening or diagnostic testing for fetal genetic disorders, regardless of maternal age.

First Trimester Risk Assessment

Trisomy 21 Screening in Twins:
Detection Rate for 5% False Positive Rate*

Twin Pregnancy	Nuchal Translucency	Combined with free ßHCG & PAPP-A
Monochorionic	73%	84%
Dichorionic	68%	70%
Singletons	73%	85%

* All tests include maternal age

Wald et al, 2003
Cleary-Goldman et al, 2005

Importance of Nuchal Translucency in Twins

- Aneuploidy
- Structural malformations
- Twin-twin transfusion syndrome
  - *PPV 30%*

SMFM and Simpson, 2013

Twin Anatomy: Fetal Anomalies

Background risk for singletons
- 2% overall

Rate same per fetus for dizygotic twins
- 2% per fetus
- 4% overall

Rate 2-3 times higher for monozygotic twins
- 4-6% per fetus
- 8-12% overall

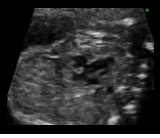
ACOG Practice Bulletin 2009

Congenital Heart Disease: Singletons vs Twins

- CHD is the leading malformation contributing to infant mortality and morbidity
- Background risk in singletons

Prevalence in midtrimester:	10 per 1000 singletons
Prevalence at birth:	8 per 1000 live births
Major cardiac defect at birth:	3-4 per 1000 live births

- Rate higher for monozygotic twins
  - 2-3% per fetus
  - 6% overall



Simpson 2011; Pettit et al, 2013

Indications for Fetal Echocardiography

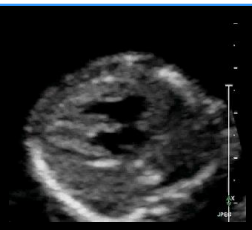
Maternal
- Autoimmune antibodies
- Familial inherited disorders
- In vitro fertilization
- Metabolic diseases
- Teratogen exposure
  - Retinoids
  - Lithium

Twins conceived by IVF at increased risk for CHD irrespective of chorionicity

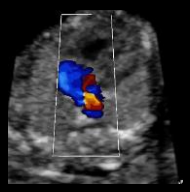
Fetal
- Abnormal cardiac screen
- First-degree relative with CHD
- Abnormal heart rate or rhythm
- Fetal chromosomal anomaly
- Extracardiac anomaly
- Hydrops
- Increased NT
- Monochorionic twins

AIUM practice guideline for the performance of fetal echocardiography; Ultrasound Med 2013
Bahtiyar et al, 2010; Reelfhuis et al, 2009

TTTS: Acquired CHD



Biventricular Hypertrophy
- >50% of recipient twins



Pulmonary Stenosis
- 5% of recipient twins

Karatza et al, Heart 2008

Screening for Fetal Anomalies: Singletons vs Twins

- Imaging difficult with greater number of fetuses in variable positions
- Monochorionic twins may be complicated by other factors that impact imaging
  - Polyhydramnios-oligohydramnios sequence
  - Discordant twin growth / sIUGR
  - Monoamnionicity
- Overall, lower detection rate expected in twins compared to the 30-50% observed in singletons

Nicolaides et al, 1999; Glinianaia et al, 2008;
Boyle et al, 2013; ACOG Practice Bulletin 2009

Discordant Anomalies

- 1-2% of twin pregnancies face the dilemma of expectant management versus selective termination

DC twins

- 3% risk of procedure-related pregnancy loss with selective reduction via intracardiac KCl

MC twins

- 5% risk of procedure-related pregnancy loss with selective reduction via cord occlusive techniques
  - 3% neurologic morbidity in surviving co-twin
  - Must weigh against 20% risk of neurologic injury if spontaneous demise of abnormal MC twin

O'Donoghue et al, 2009

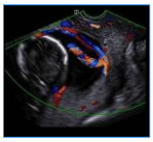
Importance of Placental Evaluation

- Placenta previa more common in twins
- Placental cord insertion more likely to be abnormal in twins
  - Marginal
  - Velamentous
  - Vasa previa

Ananth et al, 2003; AIUM 2007

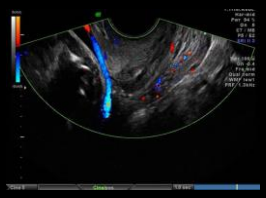
Velamentous Placental Cord Insertion

- 10% of twins compared to 1% of singletons
- Marker for unequal placental sharing with discordant twin growth/sIUGR in MCDA twins and IUGR in dichorionic twins
- 2% of velamentous PCI associated with vasa previa
- Detection rate >90-95% with routine use of transvaginal ultrasound using color and pulsed Doppler in midtrimester
- Perinatal mortality of vasa previa
  - ~50% in undiagnosed cases
  - <5% in cases identified prenatally

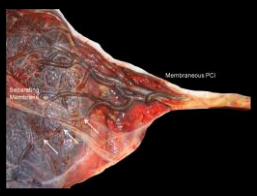


Simpson et al. ACOG 2011:204:145
Derbala et al, 2007

PCI: Ultrasound and Pathology



Vasa Previa



Velamentous PCI with intertwin anastomoses

Importance of Cervical Length

- Identify patients at risk for preterm delivery
  - Mean gestational age for live born twins = 35.4 weeks
- Potential clinical value for all twin gestations
- Transvaginal approach proven to be optimal approach to assess cervix

Imseis et al, 1997
Guzman et al, 2000

Meta-Analysis of 21 Twins Studies

- Transvaginal cervical length ≤20 mm at 20-24 wk
  - performed **best** as predictor of spontaneous preterm birth in asymptomatic women with twins

Spontaneous Preterm Birth	Sensitivity	Specificity	Positive LR	Negative LR
<28 weeks	35%	93%	5.2	0.69
<32 weeks	39%	96%	10.1	0.64
<34 weeks	29%	97%	9.0	0.74

- Cervical length >35 mm at 20-24 wk
  - high likelihood of delivery ≥34 wk, PPV >95%

Conde-Agudelo et al, 2010

Cervical Length

- Baseline assessment and serial assessments for patients at risk
  - *All twin pregnancies*
- Optimal cervical length threshold and frequency of follow-up assessments uncertain
  - *≤20 mm, two week intervals*
- Management of patient with twins and a short cervix remains controversial
  - *May be role for vaginal PG*

ACOG Practice Bulletin 2009
Durnwald et al, 2010
Klein et al, 2011

Importance of Twin Growth

- Diagnosis of twin discordance
- Detection of intrauterine fetal growth restriction
- Identify cases for increased surveillance
- Twin growth impacts delivery planning

Twin Discordance

$$\text{Discordance} = \frac{\text{(EFW of larger twin – EFW of smaller twin)}}{\text{EFW of larger twin}}$$

- 20-25% discordance considered to be significant
- Disparate abdominal circumferences early sonographic sign
- Increased discordance associated with increased risk of fetal and perinatal death compared to concordant twins

Causes of Discordant Growth

- Structural anomalies
- Chromosomal abnormalities
- Genetic syndromes
- Discordant congenital infection
- Unfavorable placental implantation
- Unfavorable cord insertion site
- Placental abruption
- Complications of monochorionic placentation

Monthly ultrasounds for fetal growth recommended for all twin pregnancies

ACOG, 2004
AIUM, 2009

Potential Complications of Monochorionic Twins

- Monoamniotic twins
- Conjoined twins
- Twin reversed arterial perfusion (TRAP) sequence
- Twin-twin transfusion syndrome (TTTS)
- Unequal placental sharing (UPS)
  - Discordant twin growth
  - Selective intrauterine growth restriction (sIUGR)
- Twin anemia-polycythemia sequence (TAPS)
- Single twin demise in the second or third trimester

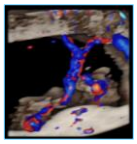
Monoamniotic Twins

- 1% of all monozygotic twins
- Results from cleavage at 8-13 days

Monoamniotic Twins

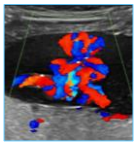
How do you make the diagnosis?

- Lack of separating membrane on serial exams
- Cord entanglement
  - Utilize color Doppler
  - Present in >80% of cases
- Single placenta with two cord insertions
  - Often in very close proximity
- Associated congenital anomalies
  - Present in 10% of cases



Monoamniotic Twins

What are your management recommendations?

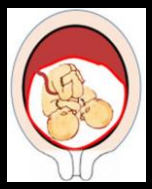


- Monthly growth scans
- Hospital admission at 24-28 weeks
- Serial surveillance
  - BPP
  - NST / continuous EFM
  - Doppler
- CD at 32-34 weeks

Contemporary management has increased survival from 50-60% to over 90%

Conjoined Twins

- Rare event
- Results from cleavage at 13-15 days



Cephalopagus

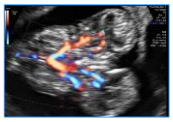
Thoracopagus

Conjoined Twins

How do you make the diagnosis?

- Monoamniotic placentation
- Same relative positions of twins to each other in all views
- Direct opposition of the twins
- Extreme extension of the fetal spines
- Shared organs, vascular connections, associated anomalies

Management recommendations?

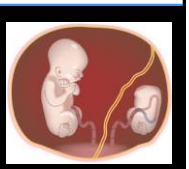


Dicephalic Parapagus

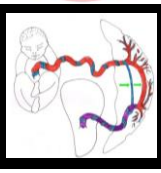
Thoracopagus

TRAP Sequence

What is twin reversed arterial perfusion sequence?



- Complication of monochorionic twins
  - Prevalence: 1:100 monochorionic twins
  - 75% diamniotic, 25% monoamniotic
- Aberrant arterioarterial anastomosis between twins
  - Acardiac twin lacks direct placental perfusion, dependent on retrograde flow from pump twin
  - Leads to abnormal development of acardiac twin



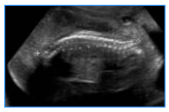
TRAP Sequence

How it is diagnosed?

- Abnormal early development of one twin of MC pair
- Acardius acephalus most common
- Paradoxical arterial flow towards the acardiac twin on pulsed Doppler

TRAP Sequence

What do you recommend?



- Pump twin at risk for anomalies (5-10%), aneuploidy (10%), 2VC (65%), and hemodynamic compromise (30%)
- Ratio of acardiac/pump twin >05-0.7 increases risk for cardiac failure (30%), polyhydramnios (50%), and PTD (90%)

Estimate size of acardiac twin:

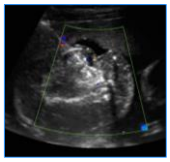
- EFW (g) = length x width x height x 0.52
- EFW (g) = (-1.66 x length) + (1.21 x length^2)

Lee et al (NAFTNet), 2013; Jellin et al, 2010; Oliver et al, 2013; Simpson 2014

TRAP Sequence

Consider invasive cord occlusion therapy when . . .

- high acardiac-to-pump ratio (≥50%)
- rapid growth of acardiac twin
- hemodynamic compromise of pump twin

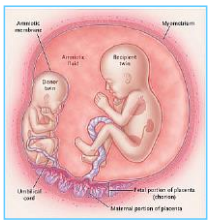


Variety of techniques available

- bipolar coagulation, radiofrequency ablation (RFA) most popular
- RFA targets intrafetal cord insertion within acardiac twin
- survival 80-90%, mean GA at delivery 34-36 weeks

Lee et al (NAFTNet), 2013
Aitken et al, 2014

Twin-Twin Transfusion Syndrome

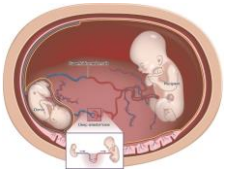


- Complicates 8-10% of monochorionic diamniotic twin gestations
- Untreated TTTS developing before the third trimester has a perinatal mortality rate of >70%
  - 15-50% risk of handicap in survivors

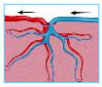
Simpson et al. ACOG 2011:204:145

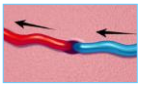
Twin-Twin Transfusion Syndrome

What it is?



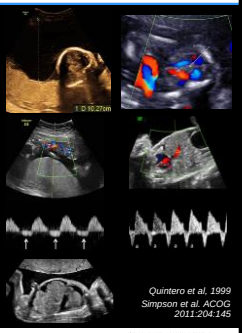
- Intertwin transfusion
  - Unequal sharing of blood
  - Changes in regional blood flow
  - Alterations in cardiac function
- Due to presence of vascular anastomoses in single placenta
  - 80-100% have intertwin anastomoses
  - Superficial bidirectional AA and VV
  - Deep unidirectional AV





Twin-Twin Transfusion Syndrome

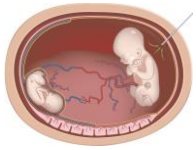
Stage	Ultrasound Assessment	Criteria
I	Amniotic fluid	MVP <2 cm in donor sac; MVP >8 cm in recipient sac
II	Fetal bladder	Nonvisualization of fetal bladder in donor twin over 60 minutes of observation
III	Doppler studies	Absent or reversed umbilical artery diastolic flow, reversed ductus venosus a-wave flow, pulsatile umbilical vein flow
IV	Fetal hydrops	Hydrops in one or both twins
V	Fetal cardiac activity	Fetal demise in one or both twins

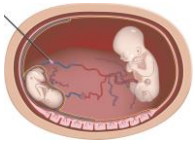


Quintero et al, 1999
Simpson et al. ACOG 2011:204:145

Twin-Twin Transfusion Syndrome

What do you recommend?





- Pregnancy termination
  - Early, advanced stage TTTS
- Amnioreduction
  - Beyond 26 weeks
  - Declines fetoscopic laser therapy
  - Fetoscopic laser therapy unavailable
- Laser photocoagulation of communicating vessels
  - 18-26 weeks
  - Advanced stage TTTS
- Delivery
  - Late presentation

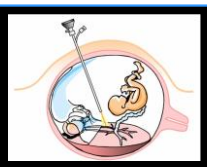
TTTS Outcomes	Stage I	Stage II	Stage III	Stage IV	Normal Neurologic Outcome at 6 months and 6 years	
Resolution	27%	10%	1%	–		
Amnioreduction					31%	70%
At least one survivor	90%	80%	48%	26%		
Two survivors	50%	48%	20%	6%		
Laser					52%	82%
At least one survivor	86%	84%	78%	62%		
Two survivors	92%	82%	66%	52%		

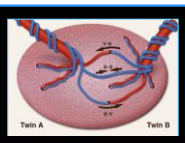
Mari et al, 2001; Hecher et al, 2000; Quintero et al, 2003; Senat et al, 2005; Galen et al, 2005; Salomon et al, 2010

- In over 1000 published cases of laser performed for TTTS from six different centers, there were:
  - Two survivors: 50%
  - Single survivor: 30%
  - No survivors: 20%
- Normal neurologic development at 2 years of age: 80-90%

Simpson et al. ACOG 2011:204:145

Fetoscopic Laser Therapy





Unequal Placental Sharing

What it is?

Pathologic discordance in territorial share of the common placenta in monochorionic twins

- Discordant twin growth
  - 20-25% discordance significant
- Selective IUGR
  - EFW ≤10th percentile of one twin

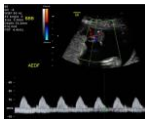
Unequal Placental Sharing

When should you be suspicious?

- Disparate CRL's and AC's are early sonographic signs of subsequent discordant growth and/or sIUGR in MC twins
- Velamentous PCI is an independent risk factor for UPS

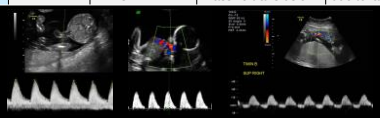
Unequal Placental Sharing

- Abnormal umbilical artery waveforms of sIUGR twin may represent effects of
  - Placental resistance
  - Type and size of intertwin anastomoses
- Leads to substantial clinical differences in apparently similar cases



UPS with sIUGR Staging

Type	UA Dopplers	Placenta	Intertwin Flow Via Anastomoses	IUFD Risk
I	Positive DF	Small placental territory, many anastomoses	Compensates for small placental share	2-4% (unpredictable)
II	Persistent AREDF	Smaller placental territory, many anastomoses	Attenuates severity of sIUGR	0-30% (predictable) Decrease risk with serial surveillance/ early delivery
III	Intermittent AREDF	Tiny placental territory, close PCIs, large AAAs	Enables survival of sIUGR twin but potential for acute, massive transfusion	10-20% (unpredictable) Unstable hemodynamics due to large AAAs



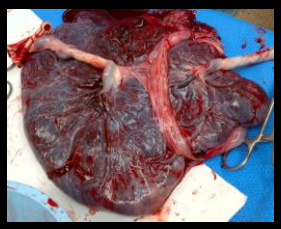
Gratacos et al, 2007
Valsky et al, 2010

UPS with sIUGR

What are your management considerations?

- Spontaneous demise of MCDA twin carries 10% risk of death of co-twin, 20% risk of neurologic injury
  - Acute anemia due to massive blood transfer from surviving twin into dead twin/placenta
- Presence of placental anastomoses may be protective for sIUGR twin – compensatory flow from its co-twin
- Management strategy remains a challenge!
  - Influenced by severity of sIUGR, coexisting TTTS, gestational age, parental decisions, technical issues

UPS versus TTTS



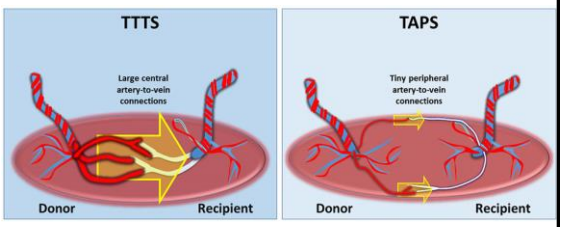
UPS with sIUGR

TTTS laser case

TAPS

What it is?

- Twin anemia polycythemia sequence
- Chronic form of fetofetal transfusion

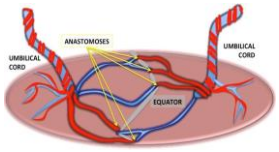


TAPS

Spontaneous (3-5% of MC twins)

Iatrogenic (10-15% post-laser)

- Residual anastomoses in 5-30% of laser cases
- Solomon technique reduces risk

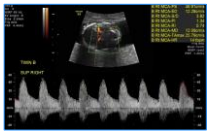


Slaghekke et al, 2010, 2014
Lopriore et al, 2009, 2010

TAPS

How is it diagnosed?

- Elevated PSV-MCA in one twin = anemia
- Decreased PSV-MCA in co-twin = polycythemia



Stage	Criteria
1	PSV-MCA >1.5 MoM in donor PSV-MCA <1.0 MoM in recipient
2	PSV-MCA >1.7 MoM in donor PSV-MCA <0.8 MoM in recipient
3	Stage 1 or 2 with cardiac compromise of donor
4	Hydrops of donor
5	Single or double IUFD

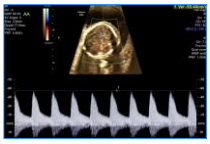
Slaghekke et al, 2010, 2014
Lopriore et al, 2009, 2010

TAPS

What are your management recommendations?

- *Depends on gestational age, technical considerations, disease severity*

Options

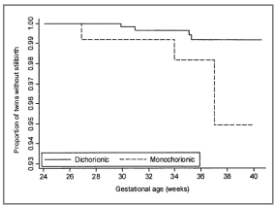


- Repeat laser: technical difficulties
- Fetal transfusion: not curative
- Cord coagulation
- Expectant management
- Early delivery

Single MC Twin Demise

Retrospective cohort analysis of 1000 consecutive twins ≥24 weeks

- 804 DCDA – 1.1% stillbirth
- 198 MCDA – 3.6% stillbirth



Analysis of 151 normal MCDA twins ≥24 weeks

All demises within 2 weeks of a normal scan

Overall risk of late fetal death in uncomplicated MCDA twins:

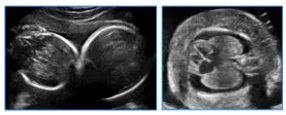
- 4.6% per pregnancy
- 3.3% per fetus

Lee et al, 2008
Barigye et al, 2005

Single MC Twin Demise: Acquired CNS Injury

Chorionicity	Co-twin death after single demise	Abnormal CNS imaging in surviving co-twin	Neurodevelopmental impairment in surviving co-twin
Dichorionic	3%	16%	2%
Monochorionic	15%	34%	26%

- For single death in MC pair, 5 times more likely to have neurologic morbidity



Griffiths et al, 2015; Hillman et al, 2011

Use of Ultrasound in Twins: Summary

Timing	Examination
1st trimester	Determination of chorionicity Measurement of crown rump lengths for dating
11-13 weeks	Measurement of nuchal translucency for screening
16-26 weeks	Screen MC twins every other week for TTTS
18-20 weeks	Screen for structural, placenta and PCI abnormalities Baseline cervical length
20-22 weeks	Fetal echocardiography for IVF and MC twins
24 weeks to delivery	Serial determination of twin growth and discordance Assessment of cervical length as indicated Antenatal fetal testing as indicated Fetal presentation prior to delivery Delivery of second twin

NICHD 2012

Take Home Message

In order to provide high-quality obstetric care of twin pregnancies, need to

- Diagnose early
- Counsel extensively
- Follow closely
- Manage using best available up-to-date evidence

which requires extensive use of ultrasound