

Discordant Anomalies in Twin Pregnancies

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Monochorionic Diamniotic Twins 14 weeks

28 y/o, Hispanic G1P0

"Domestic Engineer"

FOB ~ two jobs

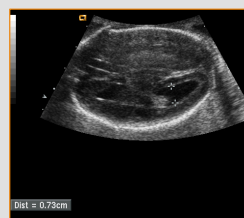
Parents live with them



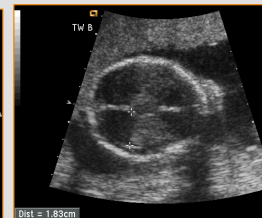
The Anticipated Future



Comprehensive Ultrasound at 20 weeks "The Reality"



Fetus A
normal



Fetus B
ventriculomegaly

Incidence of Anomalies in Twins

- 845 pairs of twins w/evaluation of zygosity:
 - - 483 monozygotic
 - - 252 dizygotic
 - - 110 zygosity unconfirmed
- Anomalies:
 - - MZ: 2.7% (82% discordant)
 - - DZ: 1% (100% discordant)
 - - Singletons: 0.6%

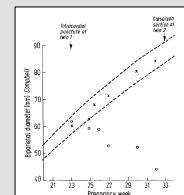
Monozygosity ~ Monochorionicity
Teratogen

Chen et al. *Acta Genet Med Gemellol* 1992;41:197-203

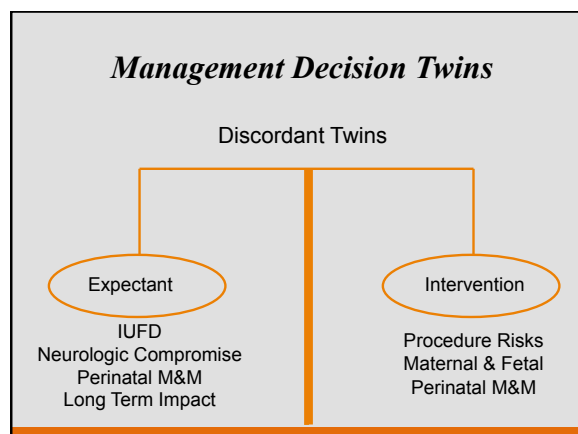
Selective Termination in Twin Pregnancies Advent of Prenatal Diagnosis

Twins discordant for malformation, genetic disorder or chromosome abnormality

- Pregnancy Termination
- Continue on behalf of the normal twin with anomalous twin having
 - Perinatal implications
 - Postnatal burden
- Selective Termination



Aberg et al *Lancet* 1978

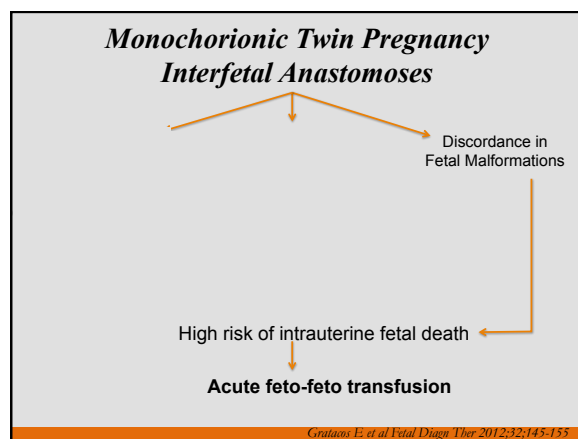


Perinatal Outcomes of Normal Cotwins in Twin Pregnancies with One Structurally Anomalous Fetus: A Population Based Retrospective Study

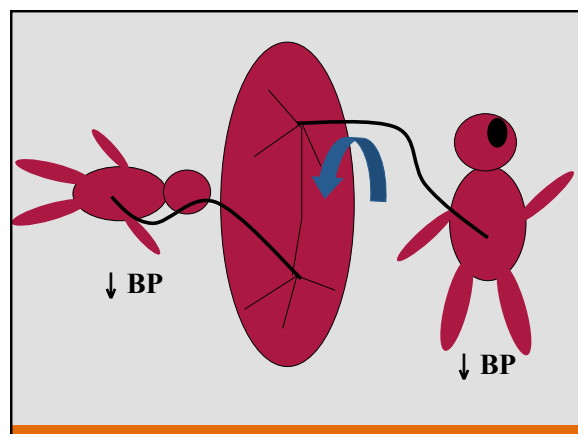
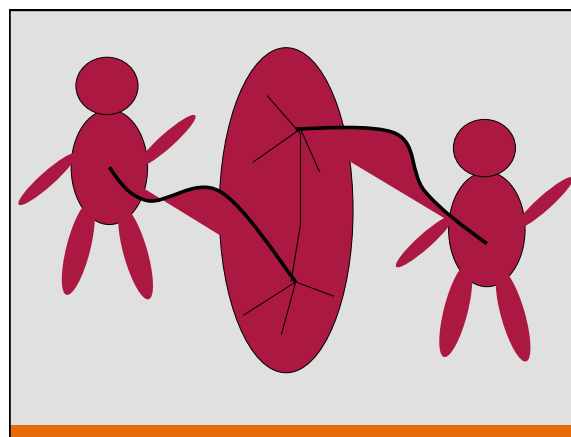
Perinatal outcomes	Nonexposed Group (n = 12,813)	Exposed Group (n = 3307)	Adjusted OR and 95% CI
Early preterm birth (<32 wk gestation)	1189 (9.28)	527 (15.94)	1.85 (1.65, 2.07)
Preterm birth (<37 wk gestation)	6786 (52.96)	2041 (61.72)	1.43 (1.32, 1.54)
Very low birth weight (<1500 g)	1035 (8.08)	467 (14.12)	1.88 (1.67, 2.12)
Low birth weight (<2500 g)	6619 (51.66)	1984 (59.99)	1.40 (1.29, 1.52)
Small-for-gestational age	1321 (10.31)	398 (12.04)	1.21 (1.07, 1.36)
Fetal distress	424 (3.61)	169 (5.67)	1.57 (1.30, 1.89)
Assisted ventilation < 30 min	511 (4.15)	185 (5.87)	1.37 (1.15, 1.64)
Assisted ventilation ≥ 30 min	470 (3.52)	297 (9.42)	2.65 (2.26, 3.10)
Apgar score at 5 min < 7	394 (3.08)	191 (5.78)	1.88 (1.57, 2.56)
Fetal death	79 (0.61)	67 (2.03)	3.75 (2.61, 5.38)
Neonatal death	108 (0.84)	54 (1.63)	2.08 (1.47, 2.94)
Infant death	164 (1.28)	80 (2.42)	1.97 (1.49, 2.61)

Data 1995-1997 US Matched Multiple Births Dataset
Matched: MA, parity, birth order, gender and sex concordance

Sun LM, et al. *Am J Perinatol* 2009



Gentilons E, et al. *Fetal Diagn Ther* 2012;32:145-155



Monochorionic Twins Management of Anomalies

Risk of *in utero* death of affected twin

- Old theory of "bad humors" crossing to the live twin discounted
- Acute hemodynamic changes the more likely etiology
- No benefit from acute delivery
- 15% of cases associated with IUFD of co-twin
 - ↑ 5X over dichorionic twins
- 34% abnormal postnatal cranial imagine with IUFD co-twin
 - ↑ 2X over dichorionic twins
- 26% of survivors with neurologic sequelae
 - ↑ 12X over dichorionic twins

Hillman SC, et al. *Obstet Gynecol* 2011;118(4):928

Outcome in twin pregnancies discordant for fetal anencephaly

	N	Mean GA Delivery	Preterm Delivery	Neonatal Survival
Dichorionic				
Feticide ¹	17	38.0	6.2%	94.1%
Observation	41	34.9	26.8%	95.1%
P		0.0002	NS	NS
Monochorionic				
Feticide ²	5	35.2	50%	80%
Observation	23	32.2	68.8%	86.9%
P		NS	NS	NS

1. Intracardiac KCl or lidocaine
2. Bipolar umbilical cord coagulation

Liaw A et al Prenat Diagn 2008

Dilemmas in management of twins discordant for anencephaly diagnosed at 11-14 weeks

Chorionicity	#	Hydramnios	Livebirth	Delivery < 33 wks
DICHORIONIC				
Expectant Obs	35	57%	97%	18%
Reduction	9	0	89%	13%
Monochorionic				
Expectant Obs	19	52%	84%*	38%
Intervention				
Laser coagulation	6		100%	33%
Cord Ligation	24		54%	69%
Bipolar	92		77%	31%

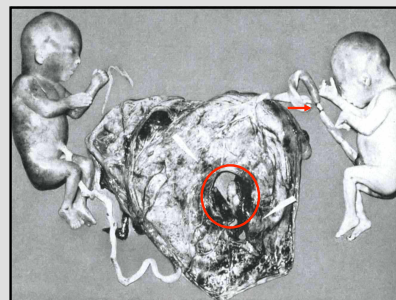
* IUFD of affected Twin with co-twin demise

Vandercruys H Ultrasound Obstet Gynecol 2006;28:563

"It may be justified to consider the ligation of one of the umbilical cords when the early recognition....indicates poor outcome"

Benirschke K & Driscoll SG (1967) The Pathology of the Human Placenta

Transuterine Ligation of the Umbilical Cord

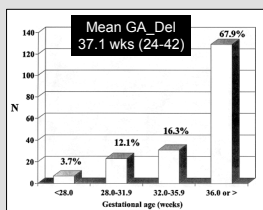


Inadvertently, the main mass of the placenta incised
Fetal exsanguinated

Selective termination* of anomalous fetuses in multifetal pregnancies: 200 cases in single center

Variable	Outcome
SAB	4%
GA Procedure	
< 20 wks	5.9%
≥ 20 wks	1.3%
#Reduced	
1	5/191 (2.6%)
2	3/7 (42.9%)
Position	
Presenting	4.5%
Nonpresenting	3.7%

*Dichorionic ~ Intracardiac KCl



Eddleman KA et al AJOG 2002

MC Multifetal Pregnancies with Discordant Anomalies Therapeutic Options for Selective Reduction

Ultrasound Guided Funicular Techniques

- Alcohol impregnated suture
- Thrombogenic materials
- Thermal Vascular Occlusion
 - Monopolar
 - Bipolar cautery

Ultrasound Guided Intrafetal Techniques

- Alcohol
- Monopolar coagulation
- Interstitial laser ablation
- Radiofrequency ablation
- Microwave

Fetoscopic Techniques

- Cord ligation
- Laser ablation
 - Placental anastomoses
 - Umbilical cord
- Occlusion with transection



IV cardiotoxic agents, such as potassium chloride (KCL) or lidocaine **contraindicated** in MC due to placental anastomoses

Acardiac Twin



Acardius acephalus

Incidence

- 1/35,000 pregnancies
- 1/100 MC twins
- 1/30 MC triplets

Most severe form of TTTS

- Arterio-arterial & veno-venous anastomoses
- Cord insertion into or immediately adjacent to pump twin's cord insertion

Pathogenesis theories

- Primary defect in cardiac embryogenesis
- Secondary to vascular anastomoses; tissue hypoxia; atrophy of heart & other organ

Acardiac Twin



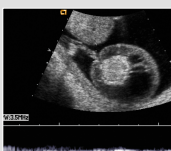
Acardius amorphus

Hemodynamically dependent on Pump

Continue growth threatens Pump

- Cardiac decompensation in pump due to high output failure with IUFD
- Polyhydramnios
 - PROM
 - Preterm labor & delivery
 - Mean gestational age without intervention 32 weeks
- Deoxygenated blood returned to Pump via V-V anastomoses
 - Chronic hypoxia
 - Fetal growth restriction
- Perinatal morbidity and mortality 35-55%

Acardiac Twin



Diagnosis

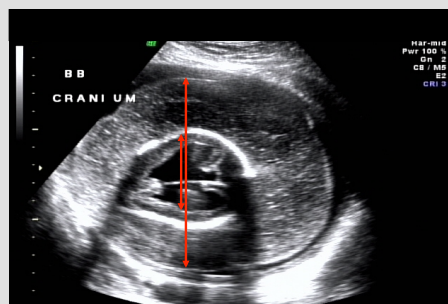
- Variable phenotype
- Grossly malformed without cardiac activity in MC twin
- Visualization of heart does not exclude diagnosis
- Retrograde perfusion color Doppler

Prognostic factor for Pump

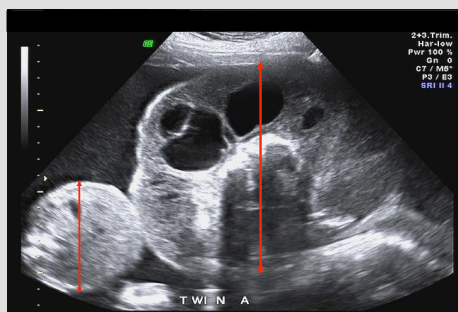
- Ratio of AC:AC } 50-70% size of pump
- Acardiac volume to pump
- Acardiac UA PI or RI
- Polyhydramnios
- Cardiac decompensation
 - Cardiomegaly
 - Pericardial effusion
 - Tricuspid regurgitation
 - Absent/reversed A-wave in DV
 - Pulsatile UV

To late to prevent neurologic compromise

Acardiac Twin



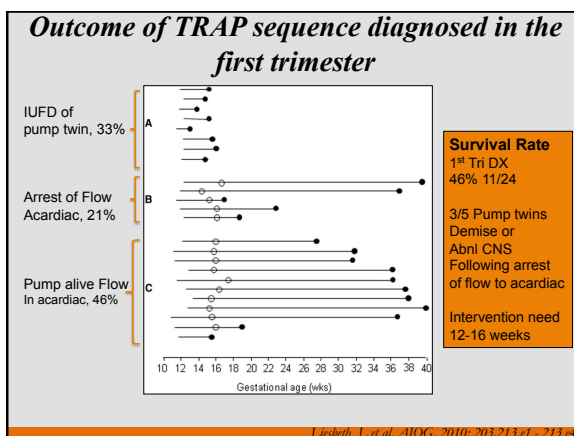
Acardiac Twin



Outcome in TRAP Pregnancies **Observation vs. Intervention** *Acardiac size < 50% of Pump*

Group	N	Acardiac Size	MOMO	Pump Survival	GA Delivery
Observation	8	27%	38%	88%	34
Intervention (RFA)	7	49%	0%	100%	36

[John E. et al Fetal Diagn Therp 2010;27:138]

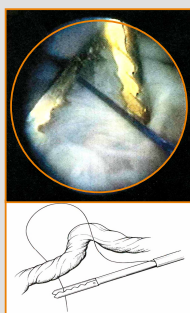


Early versus late intervention for twin reversed arterial perfusion sequence: an open-label randomized controlled trial



TRAP Intervention Study

**Fetoscopic Directed
Umbilical Cord Ligation**



Indication	
TRAP	16
TTTS	6
Discordant Anomaly	1
Gestational age	
Procedure	20
Delivery	26
Failed procedure	9%
IUFD Co-twin	19%
PPROM	
< 32 wks	35%
> 32 wks	12%
Neonatal Survival	65%

Debreux J-A et al European J Obstet Gynecol 1998;81:157-164

**Fetoscopic laser coagulation
TRAP Sequence**

Treatment	
Placental laser	18
Umbilical cord ablation	42
Gestational age	
Procedure	18 (14-25)
Delivery	37* (24-41)
Successful	
Laser alone	82%
Laser w/ Bipolar forceps	15%
PPROM < 34 weeks	18%
Survival rate	80%

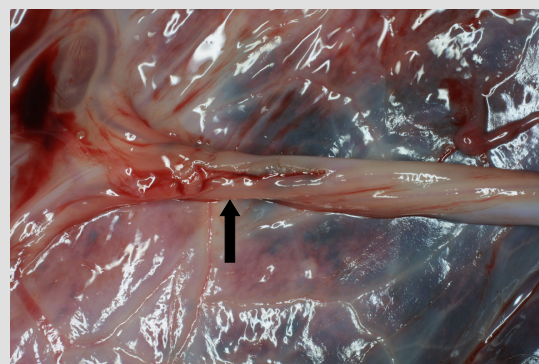
* 67% > 36 weeks

Heider K et al Ultrasound Obstet Gynecol 2006;28:688-691

**Umbilical Cord Occlusion via Laser Coagulation in
MC Multifetal Gestations before and after 20 wks
(n = 43)**

Characteristic	< 20 wk (n = 22)	≥ 20 wks (n = 21)
DX		
Discordant Anomaly	7	4
TRAP	15	17
High Order Multiple	6	3
Successful L-UCO	90%	100%
PPROM	22.7%	19.3%
GA_Delivery	34.4	35.7
Survival		
Co-twin	91%	100%
Singleton	100%	67%

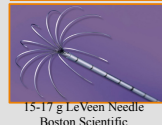
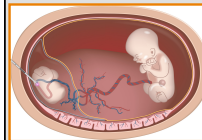
King JR et al Fetal Diagn Ther 2017



Monochorionic Triamniotic Triplet Gestation Twin Twin Transfusion syndrome



TRAP~ Interstitial Ablation



Radiofrequency Ablation (RFA)

- High frequency (200-1200 kHz)
- Alternating current tissue ions become agitated attempting to align in electrical field
- Frictional heat generated causing tissue coagulation and necrosis
- Ablation
 - Nerve roots for neuralgia
 - Cardiac tissue for arrhythmias
- Tumors
 - Lung
 - Bone
 - Renal
 - Liver

RFA of Acardiac Twin



NAFTNet Registry Data on Outcomes of RFA treated TRAP Sequence

	MCMA	MDA	Triplets	P
Total	6	81	11	
Size 25-75 th %	100 (46-77)	90 (64-111)	94 (55-134)	NS
GA_Pro	19.4	20.3	199.9	NS
GA_Birth	26.7	33.9	33.5	0.04
PPROM	1	16	0	NS
Survival	33%	83%	64%	0.003

UTHealth | McGovern
The University of Texas at Houston | Medical School

THE FETAL
CENTER

Children's
MEMORIAL
HERMANN
Hospital

Lee H et al Fetal Dis & Therapy 2013

Radiofrequency Ablation in TRAP Sequence

Advantages

- < 16 wks to early 3rd trimester
- Technical advantages
 - Small diameter needle
 - Less maternal discomfort and morbidity
 - Local anesthesia
- Appears to have least procedure related complications & failure rates
- Tines allow precision delivery of thermal energy

Disadvantages

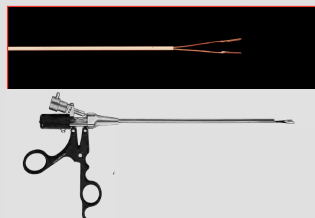
- Cost
 - Generator ~ \$20-25,000
 - Needle \$1,500
 - Insulated pads \$500
- Needle length 12-15 cm
 - Limited in obese patient
 - Late in gestation if target distal
- Doppler evaluation is not available during ablation.
- Operator skills, learning curve

Incorrect needle placement
patent umbilical vein and
artery at the level of the
umbilicus



Moise K et al Am J Obstet Gynecol 2008;198:198.e1-198.e5.

Bipolar Forceps



Everest Medical
3.0 mm

Optical Bipolar
2.4 & 3.0 mm
14Fr Cannula

Bipolar Cord Occlusion ~TRAP 18 weeks



Systemic review & meta-analysis of perinatal outcomes after RFA and BPC in MC pregnancies

Procedure	Indication	N	Overall
RFA	TTTS	49	67.3%
	TRAP	153	79.1%
	Other	94	76.6%
BPC	TTTS	194	76.8%
	TRAP	73	79.5%
	Other	127	76.5%

Other: sIUGR, discordant anomalies, and multifetal reduction

Querry K et al. AJOG 2015

Systemic review & meta-analysis of PPRM after RFA and BPC in MC pregnancies

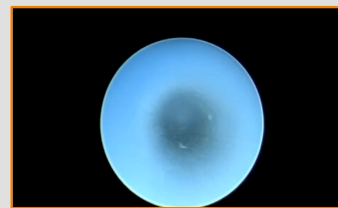
Study or Subgroup	BCO		RFA		Weight	M-H, Fixed, 95% CI	Odds Ratio M-H, Fixed, 95% CI
	Events	Total	Events	Total			
Bebbington 2012	64	88	50	58	67.7%	0.43 [0.18, 1.03]	
Roman 2010	31	40	19	20	23.5%	0.18 [0.02, 1.55]	
Van Den Bos 2013	31	36	10	11	8.8%	0.62 [0.06, 5.95]	
Total (95% CI)		164		89	100.0%	0.39 [0.18, 0.83]	
Total events	126		79				
Heterogeneity: Chi ² = 0.70, df = 2 (P = 0.71); I ² = 0%							
Test for overall effect: Z = 2.45 (P = 0.01)							

Size Does Matter

RFA 17 g vs BPC 3mm (10 Fr)

PPROM less often with RFA (OR 0.39; 95% CI, 0.18-0.83))

Cord Occlusion followed by laser cord transection in MCMA Discordant Twins



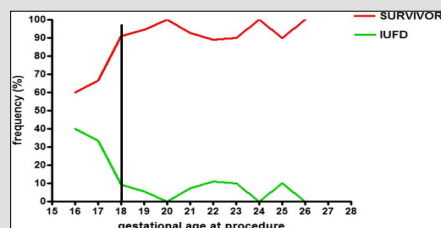
Valdes DV et al. Ultrasound Obstet Gynecol 2011;37:684; Middeldorp JM. Fetal Diagn Ther 2008;23:121

Cord occlusion followed by laser cord transection in monochorionic monoamniotic discordant twins

	MCMA	MCDA	P
OR Time (minutes)	29	24	0.24
PPROM	35%	21%	0.22
IUFD	0	3%	1.0
GA_Del	35 (25-39)	37 (26-40%)	1.0
Survival	77%	81%	1.0

Valdes DV et al. Ultrasound Obstet Gynecol 2011

Survival rate for gestational age at intervention



≤ 18 wks: 69% vs. > 18 wks 89%,
P = 0.02; OR 0.28 (95%CI 0.10-0.80)

Rossi AC et al. Am J Obstet Gynecol 2009;200:123

Conclusion

- Discordance malformations place “normal” co-twin at increased risk perinatal mortality and morbidity
- Pregnancy loss follow selective reduction is related to
 - Technique and operator experience
 - GA of procedure (DC > 20 weeks? & MC > 18 wks)
- Selective reduction for discordance malformations
 - DC twins lower incidence of prematurity; survival with or without SR is approximately the same
 - Excluding TRAP, the extent to which outcomes are improved with SR in MC gestations remains to be determined.

***“It’s tough to make predictions,
especially about the future...”***

Yogi Berra

Thank you for your attention