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Facultad de Medicina, Universidad de Chile



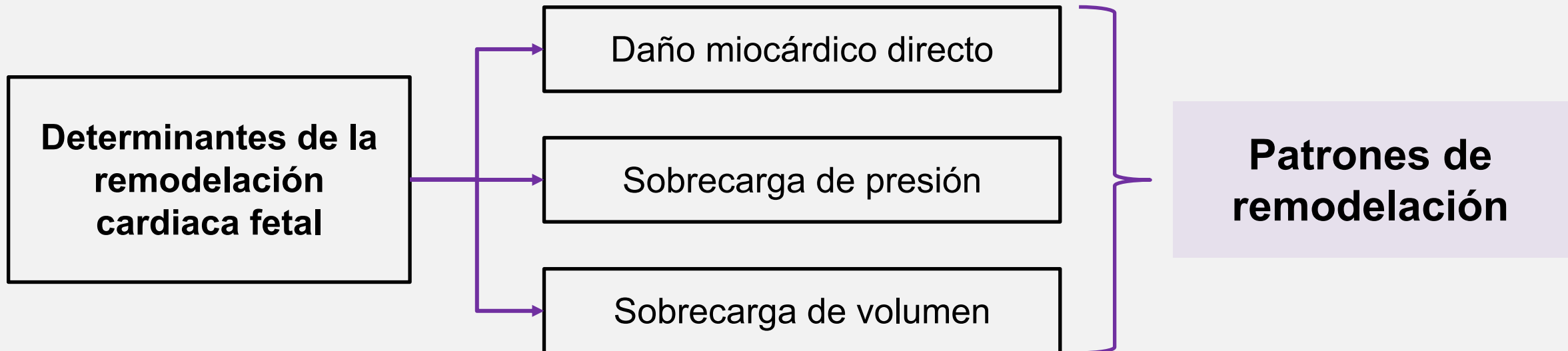
REMODELACIÓN CARDIACA EN FETOS CONCEBIDOS POR TECNOLOGIAS DE REPRODUCCIÓN ASISTIDA

Alejandro Rojas Senzano

Programa de formación medicina materno fetal

Universidad de Chile

Adaptación cardiaca mediante cambios en la forma, estructura y tamaño para mantener una función óptima y eficiente



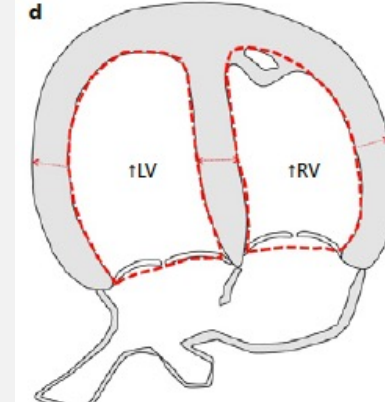
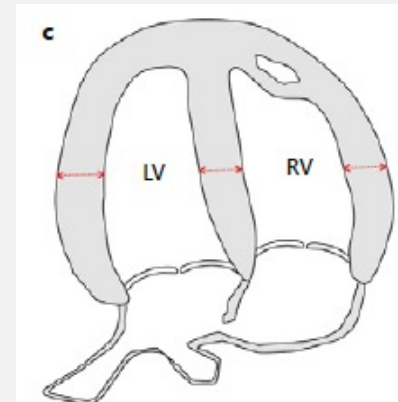
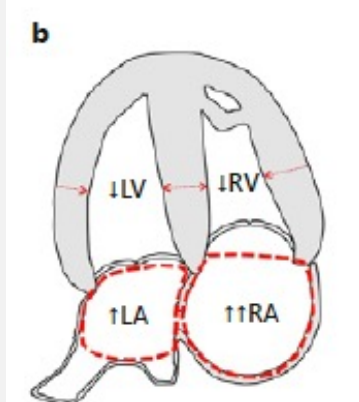
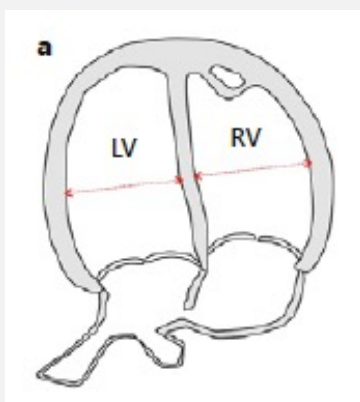


Forma globular

Hipertrofia miocárdica con tamaño normal

Hipertrofia miocárdica con cardiomegalia

Hipertrofia miocárdica excéntrica



Ventrículos esféricos
Tamaño cardíaco normal

Hipertrofia miocardio
Reducción de tamaño ventricular
Dilatación auricular

Hipertrofia miocardio
Dilatación ventricular
Disfunción sistólica/diastólica

Cardiomegalia
Ventrículos dilatados e hipertroficados

RCF leve

Estenosis pulmonar severa,
ART

AZT

RCF severo y precoz





4% de los nacimientos en países desarrollados son producto de ART

8 millones de niños han nacido producto de ART a nivel mundial

Predisposición a reprogramación del sistema cardiovascular

Remodelado y disfunción cardíaca en útero persiste en vida postnatal

Disfunción cardíaca pero sin cambios en morfología

Aumento de VD y disfunción diastólica en preadolescentes en condiciones de altura



¿Por qué existe diferencia entre los resultados?

Otros factores asociados a remodelación cardiaca

Edad materna
Embarazo múltiple
Prematuridad
Bajo peso al nacer

Diferentes ART

Fertilización in vitro
Inyección intracitoplasmática espermatozoide
Donación de ovocitos
Inseminación intrauterina
Transferencia de embriones congelados

Objetivo: evaluar remodelado cardiaco en fetos concebidos por ART controlando variables confundentes

Prospectivo observacional
Fetos ART vs controles
Evaluación entre 28⁺⁰ y 32⁺⁶ semanas
Embarazos únicos sin patologías
Seguimiento a los 0-2 y 6 meses

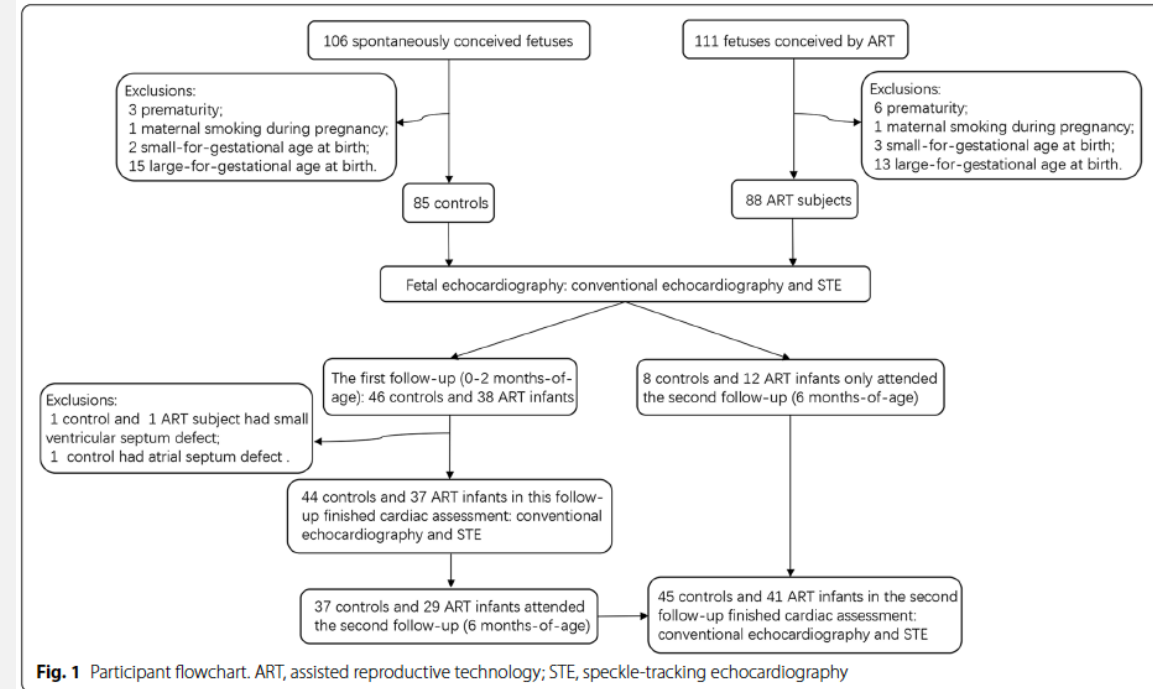


Table 1 Baseline and perinatal characteristics of the study population

Characteristics	SC (n=85)	ART (n=88)	P
Maternal characteristics			
Age (years)	33.0 (31.5, 36.0)	34.0 (31.0, 36.0)	0.793
BMI (kg/m ²)	26.11±3.44	25.74 (24.06, 28.29)	0.500
Han, % (n)	85.88 (73)	86.36 (76)	0.927
Nulliparity, % (n)	56.47 (48)	89.77 (79)	<0.001
Family cardiovascular history, % (n) ^a	57.65 (49)	48.86 (43)	0.247
Low socioeconomic level, % (n)	18.82 (16)	28.41 (25)	0.138
University education, % (n)	87.06 (74)	70.45 (62)	0.008
Paternal characteristics			
Age (years)	34.8±4.3	35.7±4.1	0.165
BMI (kg/m ²)	25.77±3.34	25.32±3.48	0.386
Han, % (n)	88.24 (75)	88.64 (78)	0.934
Cigarette smoker, % (n)	34.12 (29)	43.18 (38)	0.221
Family cardiovascular history, % (n) ^a	57.65 (49)	53.41 (47)	0.575
Low socioeconomic level, % (n)	5.88 (5)	13.64 (12)	0.087
University education, % (n)	85.88 (73)	70.45 (62)	0.014
Fertility and ART characteristics			
Infertility cause, % (n)			
Unexplained	-	12.50 (11)	-
Female	-	45.45 (40)	-
Male	-	18.18 (16)	-
Female + male	-	23.86 (21)	-
ART technique, % (n)			
IVF	-	54.55 (48)	-
ICSI	-	43.18 (38)	-
IVF+ICSI	-	2.27 (2)	-
Transferred embryos, % (n)			
1	-	25.00 (22)	-
2	-	73.86 (65)	-
3	-	1.14 (1)	-
FET, % (n)	-	76.14 (67)	-

Pregnancy complications, % (n)

Preeclampsia	4.71 (4)	9.09 (8)	0.256
Gestational diabetes	23.53 (20)	18.18 (16)	0.386
Placenta previa	2.35 (2)	4.55 (4)	0.710
Obstetric cholestasis	0 (0)	0 (0)	1.000
Prenatal corticoid exposure	1.18 (1)	2.27 (2)	1.000

Delivery data

Gestational age at delivery (week)	39.6±1.0	39.5±0.9	0.694
Cesarean section, % (n)	48.24 (41)	72.73 (64)	0.001
Male, % (n)	47.06 (40)	52.27 (46)	0.493
Birth length (cm)	51.8 (49.5, 53.0)	51.8 (49.9, 53.0)	0.550
Birth weight (g)	3380±280	3448±316	0.138

Neonatal outcome, % (n)

Admission to NICU	1.18 (1)	0 (0)	0.491
Major neonatal morbidity ^b	0 (0)	0 (0)	1.000
Perinatal mortality	0 (0)	0 (0)	1.000

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↑ áreas ventriculares derecha e izquierda

↓ índice de esfericidad de VI

Aumento de E' mitral

Reducción de GLS y velocidad de GLS

Pared de VD más delgada

Mayor ratio E/A tricúspide

> Área de superficie corporal

Sin diferencias en evaluación cardiológica

Resultados en niños concebidos por ART

Bi, W., Xiao, Y., Wang, X. *et al.* The association between assisted reproductive technology and cardiac remodeling in fetuses and early infants: a prospective cohort study. *BMC Med* **20**, 104 (2022). <https://doi.org/10.1186/s12916-022-02303-6>

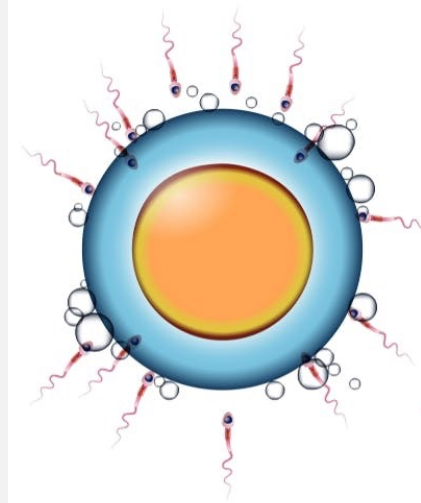


Según tipo de ART y tipo de embrión



ICSI

VS



IVF

Embriones
congelados

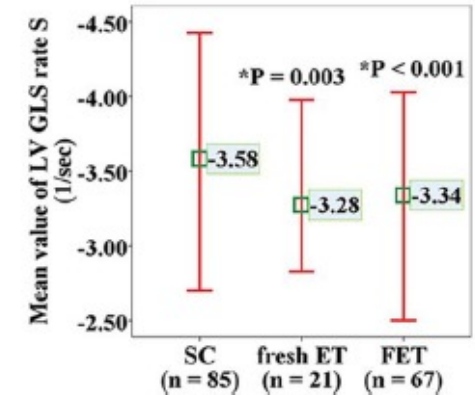
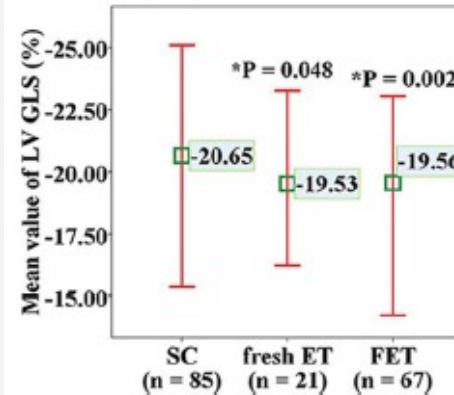
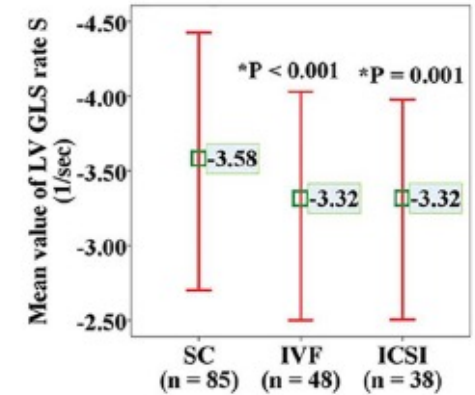
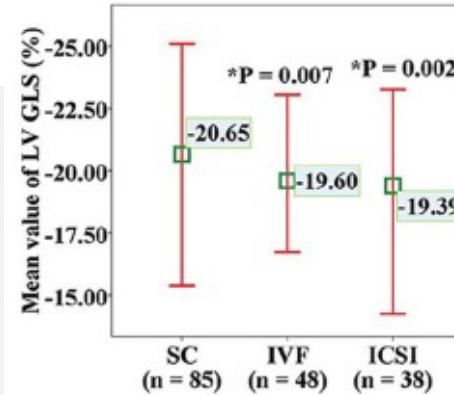
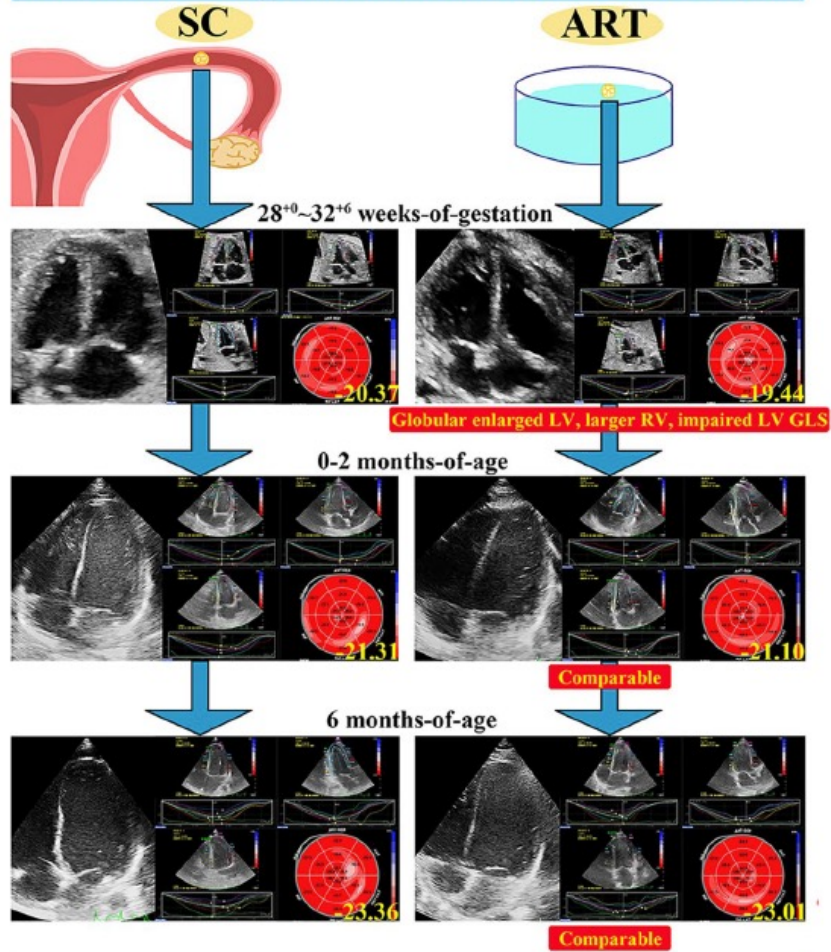
VS

Embriones
no
congelados

Sin diferencias en términos de morfología o función cardíaca



Cardiac changes in ART fetuses and infants



Fetos concebidos por ART poseen remodelado cardiaco que no persiste en la infancia

¿Por qué existe remodelado cardiaco en fetos concebidos por ART?

Respuesta a incremento en sobrecarga de VD

Mecanismos epigenéticos

Metilación en promotor de gen eNOS en aorta

Estrés oxidativo generado por ART

Incremento de ROS intracelular en ratones

Incremento de proteínas asociadas a estrés oxidativo en arteria umbilical

Fetos con **RCF** tienen corazones menos eficientes, **ventrículos mas globulares**, disminución de desplazamiento longitudinal y **alteración de la relajación**

Estos cambios están presentes en el útero y persisten postnatal

Existe **mayor incidencia de RCF** en fetos concebidos por ART

No esta claro cuando del RCF aporta en la remodelación cardiaca en ART

Objetivo: evaluar efecto diferencial de RCF y ART en desarrollo cardiovascular fetal

Estudio cohorte prospectivo
 Ecocardiografía y Doppler entre
 28-32 semanas
 4 grupos: AGA SC, AGA ART, SGA SC y SGA ART

Characteristic	Controls (n = 102)	ART-AGA (n = 72)	ART-SGA (n = 31)	Spont-SGA (n = 28)	P
Maternal					
Age (years)	33 ± 5	36 ± 3*	36 ± 3*	34 ± 4†	< 0.001
BMI (kg/m ²)	23.3 ± 4.0	24.8 ± 5.6	23.5 ± 3.1	22.5 ± 3.5	0.065
Smoker	10 (9.8)	4 (5.6)	2 (6.5)	4 (14.3)	0.489
Caucasian	83 (81.4)	64 (88.9)	29 (93.5)	26 (92.9)	0.224
Nulliparous	58 (56.9)	40 (55.6)	13 (41.9)	14 (50.0)	0.485
Family history of early CVD	2 (2.0)	2 (2.8)	0 (0)	2 (7.1)	0.453
Low socioeconomic status	16 (15.7)	17 (23.6)	6 (19.4)*†	14 (50.0)	0.007
Paternal					
Age (years)	35 ± 6	38 ± 4*	38 ± 5*	36 ± 5	0.001
BMI (kg/m ²)	25.6 ± 3.1	26.2 ± 4.2	25.0 ± 2.5	25.8 ± 4.3	0.478
Smoker	32 (31.4)	24 (33.3)	9 (29.0)	12 (42.9)	0.378
Caucasian	99 (97.1)	69 (95.8)	29 (93.5)	26 (92.9)	0.761
Perinatal					
Prenatal corticoid exposure	2 (2.0)	3 (4.2)	4 (12.9)	9 (32.1)*††	< 0.001
Pre-eclampsia	0 (0)	0 (0)	1 (3.2)*†	1 (3.6)*†	0.063
GA at delivery (weeks)	40 ± 1	39 ± 1	39 ± 1	38 ± 1	0.766
Cesarean section	25 (24.5)	20 (27.8)	14 (45.2)	14 (50.0)	0.180
Male neonate	50 (49.0)	31 (43.1)	18 (58.1)	16 (57.1)	0.560
Birth weight (g)	3300 ± 445	3305 ± 433	2480 ± 613*†	2105 ± 793*††	< 0.001
Birth-weight centile	50 ± 23	53 ± 27	4 ± 2*†	0 ± 3*†	< 0.001
5-min Apgar score	9.8 ± 0.9	9.8 ± 0.1	9.8 ± 0.1	9.9 ± 0.2	0.767
Umbilical artery pH	7.2 ± 0.1	7.2 ± 0.1	7.2 ± 0.1	7.2 ± 0.1	0.584
Neonatal					
Admission to NICU	2 (2.0)	2 (2.8)	2 (6.5)	11 (39.3)*††	< 0.001
Major neonatal morbidity	1 (1.0)	1 (1.4)	2 (6.5)	9 (32.1)*††	< 0.001
Perinatal mortality	0 (0)	0 (0)	0 (0)	1 (3.6)	0.119



Cambios morfológicos

AGA-SC tenían corazones de mayor tamaño

ART tenían aurículas mas grandes

SGA y ART mostraron corazones mas globulares e incremento relativo de grosor miocardio

SGA y ART mostraron corazones mas globulares e incremento relativo de grosor miocardio

Ultrasound parameter	Controls (n = 102)	ART-AGA (n = 72)	ART-SGA (n = 31)	Spont-SGA (n = 28)	Adjusted P§
GA at scan (weeks)	29.0 ± 0.9	29.1 ± 0.7	29.0 ± 0.7	29.3 ± 0.7	0.880
Standard fetoplacental Doppler					
Uterine artery mean PI	0.64 ± 16	0.72 ± 18	0.77 ± 25	0.98 ± 31*†‡	0.005
Cerebroplacental ratio	1.95 ± 0.4	2.00 ± 0.4	1.60 ± 0.4†	1.62 ± 0.4*†	0.305
Ductus venosus PI	0.52 ± 0.1	0.55 ± 0.1	0.54 ± 0.1	0.60 ± 0.1	0.894
Aortic isthmus flow index	1.30 ± 0.1	1.29 ± 0.1	1.32 ± 0.1	1.25 ± 0.1	0.646
Cardiac morphometry					
Cardiothoracic ratio (%)	24 ± 3	24 ± 4	23 ± 3	29 ± 6*†‡	0.921
Left atrium/heart area ratio (%)	15 ± 2.7	18 ± 4.1*	17 ± 1.7	14 ± 3.7†‡	0.025
Right atrium/heart area ratio (%)	16 ± 2.9	19 ± 3.8*	18 ± 2.3	16 ± 3.8†‡	0.002
LV sphericity index	1.77 ± 0.2	1.68 ± 0.2*	1.72 ± 0.1*	1.72 ± 0.2*†	0.085
LV relative wall thickness	0.48 ± 0.17	0.54 ± 0.13*	0.55 ± 0.12*	0.63 ± 0.23*†	0.002
RV sphericity index	1.60 ± 0.2	1.40 ± 0.1*	1.52 ± 0.1*	1.54 ± 0.2*†	0.005
RV relative wall thickness	0.46 ± 0.10	0.52 ± 0.09*	0.51 ± 0.10*	0.62 ± 0.14*†‡	< 0.001

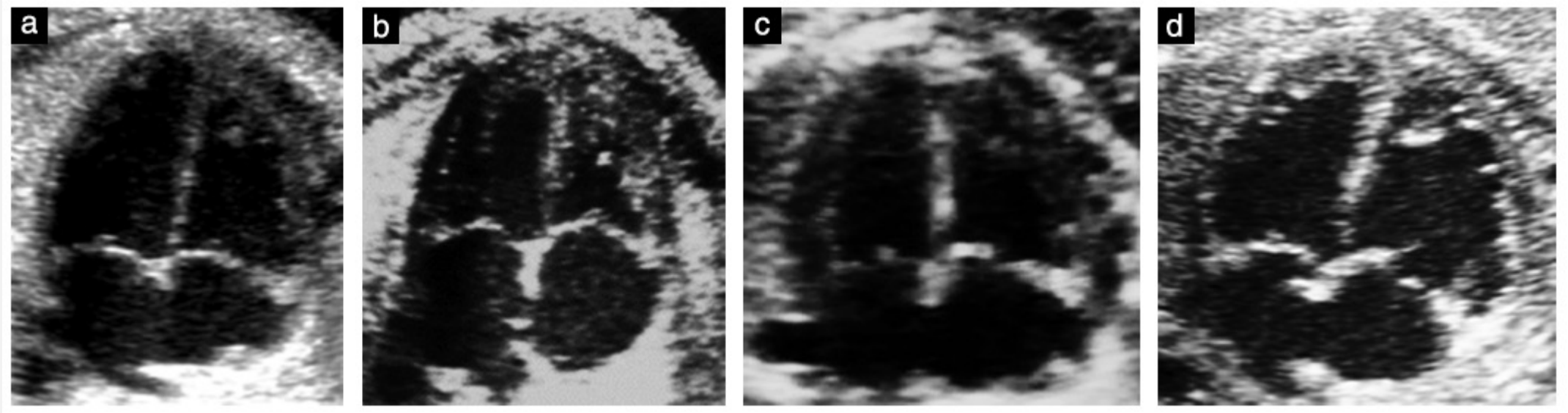
Cambios funcionales

Systolic function					
Heart rate (bpm)	141 ± 8.5	141 ± 8.4	144 ± 10.8	139 ± 13.7	0.922
LV ejection fraction (%)	67 ± 7.1	66 ± 8.3	64 ± 9.6*	71 ± 6.1	0.893
RV ejection fraction (%)	68 ± 6.7	67 ± 8.5	66 ± 7.0	65 ± 7.3	0.266
Mitral ring displacement (mm)	4.8 ± 0.7	4.3 ± 0.8*	4.1 ± 0.8*	4.1 ± 0.6*†‡	0.004
Tricuspid ring displacement (mm)	6.5 ± 0.8	5.5 ± 0.7*	5.7 ± 0.7*	5.9 ± 0.8*†	0.001
Mitral S' (cm/s)	6.9 ± 1.0	6.4 ± 1.2*	5.9 ± 0.9*†	5.6 ± 0.6*†	0.001
Tricuspid S' (cm/s)	7.3 ± 1.1	7.0 ± 1.1	7.1 ± 0.9	7.1 ± 1.1	0.162
Diastolic function					
Mitral E/A ratio	0.72 ± 0.1	0.76 ± 0.1	0.73 ± 0.8	0.78 ± 0.9	0.163
Tricuspid E/A ratio	0.72 ± 0.1	0.73 ± 0.1	0.73 ± 0.1	0.76 ± 0.1	0.087
Mitral E deceleration time (ms)	73 ± 26.8	62 ± 19.5*	76 ± 19.1	86 ± 27.7*†‡	0.278
Tricuspid E deceleration time (ms)	60.5 ± 20	52.0 ± 18.7*	56.5 ± 14.4	71.0 ± 30.1*†‡	0.960
Mitral E' (cm/s)	7.6 ± 1.0	6.8 ± 1.2*	7.0 ± 1.0*	6.0 ± 1.1*†‡	0.087
Tricuspid E' (cm/s)	8.4 ± 1.12	7.7 ± 1.20*	8.0 ± 1.3*	7.1 ± 1.0*	0.002
Mitral A' (cm/s)	10.0 ± 2.30	9.81 ± 2.61*	9.66 ± 1.71*	7.38 ± 1.73*	0.025
Tricuspid A' (cm/s)	11.4 ± 1.61	10.8 ± 1.80	10.5 ± 1.61*	9.61 ± 2.00*†	0.003
Left IRT (ms)	47.0 ± 7.3	50.0 ± 7.9*	49.0 ± 6.5*	49.5 ± 9.3	0.054

FE conservada en todos los grupos

↓ Desplazamiento longitudinal en ART y SGA

↑ tiempo relajación isovolumétrica en ART y SGA

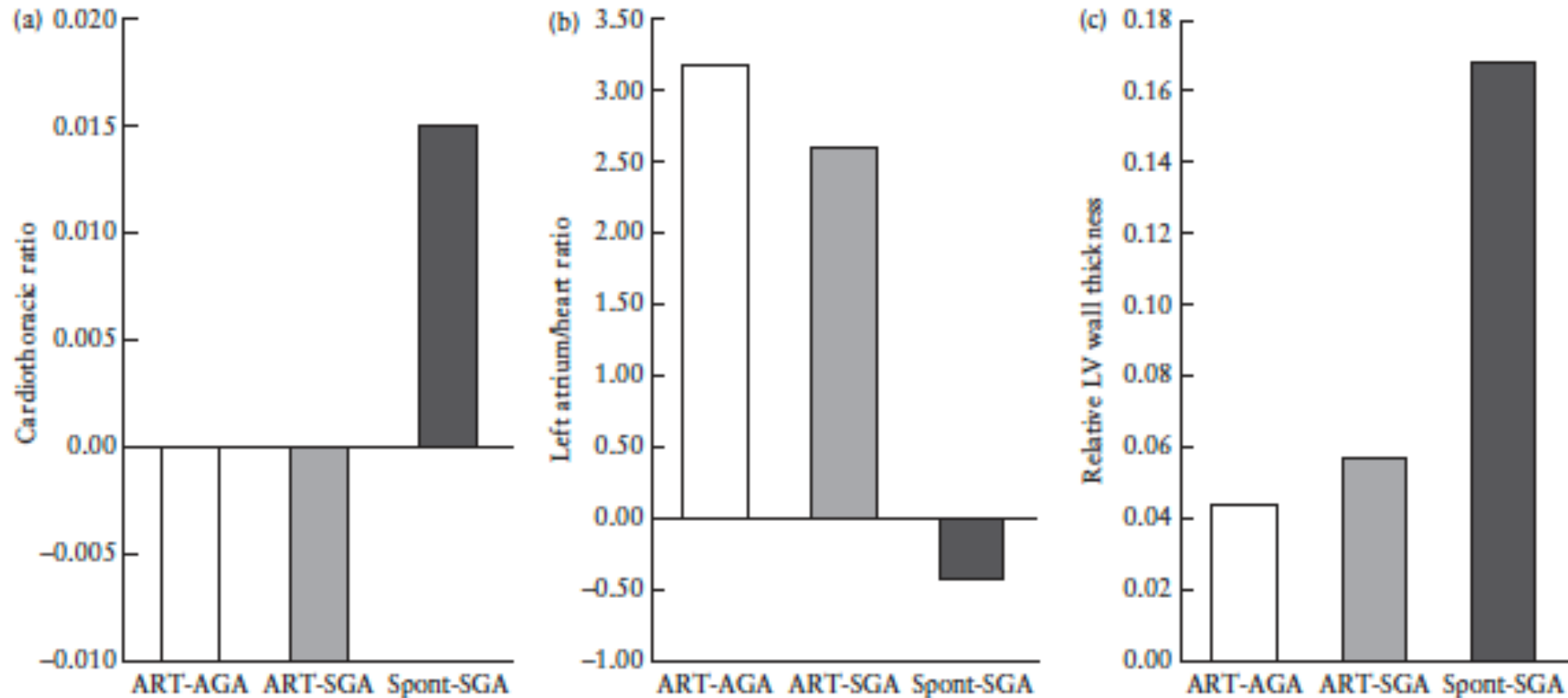


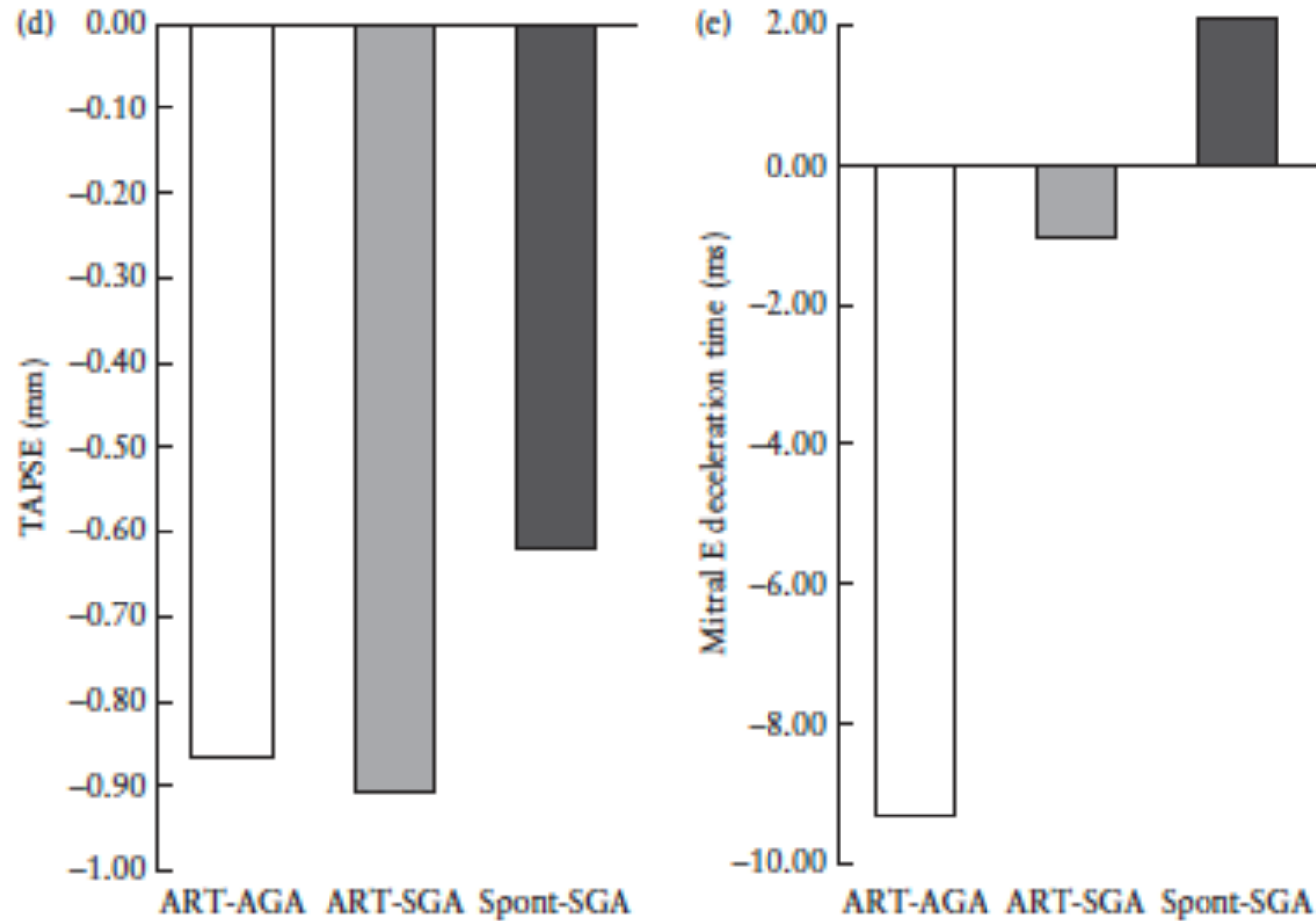
Control

AGA-ART

SGA-ART

SGA-SC







Fetos SGA SC tienen corazones globulares e hipertróficos con disfunción diastólica y sistólica

AGA-ART aurículas dilatadas y ventrículos mas esféricos, sin cardiomegalia

SGA-ART mostraron características mixtas de ambos fenotipos

Tanto fetos ART como SGA tienen un efecto directo e independiente en el sistema cardiovascular





Objetivo: evaluar remodelado y disfunción cardíaca en embarazos múltiples concebidos por ART

Estudio de cohorte prospectivo
50 gemelos ART y 50 SC
Se excluyeron monocoriales, enfermedades medicas maternas y muerte de un gemelo

Characteristic	SC twins (n = 50)	ART twins (n = 50)	P
Maternal			
Age (years)	32 ± 4	35 ± 3	< 0.001
BMI (kg/m ²)	23 ± 3.4	23 ± 4.2	0.643
Smoking	12	20	0.187
Primiparous	40	58	0.142
Paternal			
Age (years)	33 ± 3	38 ± 4	< 0.001
BMI (kg/m ²)	25 ± 4.0	27 ± 5.6	0.023
Smoking	40	36	0.539
Pregnancy complications			
Pre-eclampsia	4	20	0.018
Corticoid exposure	20	30	0.117
Gestational diabetes	4	8	0.803
Delivery data			
GA (weeks)	37 ± 2.3	37 ± 2.5	0.298
Cesarean section	60	70	0.041
Male gender	60	52	0.919
Birth weight (g)	2529 ± 483	2493 ± 603	0.967
Birth weight centile	60 ± 28	57 ± 32	0.269
SGA	6	8	0.516
Umbilical artery pH	7.27 ± 1.15	7.27 ± 0.5	0.440
Neonatal outcome			
Admission to NICU	4	16	0.043
Major neonatal morbidity*	2	10	0.028

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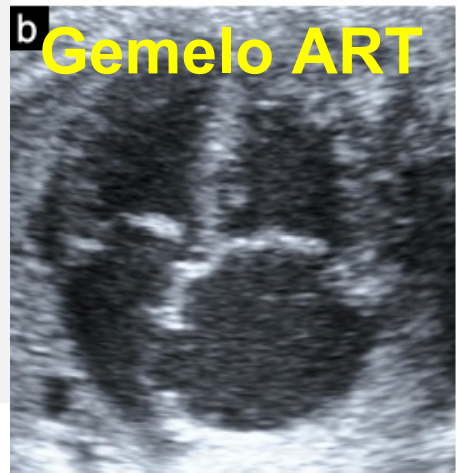


Morfología

Tamaño cardiaco similar

Aurículas mas grandes

Ventrículos mas globulares y gruesos



Función

Reducción de TAPSE

Menor E'

Fracción de eyección conservada



Characteristic	SC twins (n = 50)	ART twins (n = 50)	Adjusted P*
Gestational age at ultrasound examination (weeks)	29 ± 0.85	29 ± 0.69	0.236
Standard fetoplacental data			
Estimated fetal weight (g)	1302 ± 171	1246 ± 126	0.288
Estimated fetal weight (centile)	57 ± 26	56 ± 25	0.343
Uterine artery mean PI	0.68 ± 0.18	0.69 ± 0.17	0.403
Umbilical artery PI	1.09 ± 0.23	1.13 ± 0.26	0.738
Middle cerebral artery PI	1.93 ± 0.43	2.03 ± 0.38	0.128
Cerebroplacental ratio	1.61 ± 0.71	1.78 ± 0.69	0.060
Ductus venosus PI	0.55 ± 0.13	0.58 ± 0.16	0.671
Aortic isthmus PI	2.35 ± 0.28	2.47 ± 0.34	0.265
Cardiac morphometric data			
Cardiothoracic ratio	0.25 ± 0.06	0.24 ± 0.03	0.715
Left atrial/heart ratio	12.5 ± 0.3	13.2 ± 0.3	0.010
Right atrial/heart ratio	15.7 ± 3.1	18.4 ± 3.2	< 0.001
Left ventricular sphericity index	1.77 ± 0.30	1.67 ± 0.20	0.635
Right ventricular sphericity index	1.57 ± 0.25	1.41 ± 0.23	0.001
Left ventricular free wall thickness (mm)	2.70 ± 0.54	2.99 ± 0.42	0.111
Septal wall thickness (mm)	2.57 ± 0.45	2.84 ± 0.41	0.034
Right ventricular free wall thickness (mm)	2.80 ± 0.48	3.10 ± 0.38	0.025



F: Systolic function

Left ejection fraction (%)	68.5 ± 9.0	69.5 ± 9.1	0.733
Right ejection fraction (%)	66.8 ± 9.4	69.8 ± 9.3	0.276
MAPSE (mm)	4.87 ± 0.69	4.70 ± 0.89	0.577
TAPSE (mm)	6.36 ± 0.89	5.18 ± 0.93	< 0.001
Mitral S' (cm/s)	6.9 ± 0.9	6.8 ± 1.0	0.423
Tricuspid S' (cm/s)	9.1 ± 1.1	7.2 ± 1.0	0.412
Septal S' (cm/s)	6.2 ± 1.1	6.2 ± 1.1	0.268
Diastolic function			
Mitral E/A ratio	0.74 ± 0.10	0.74 ± 0.09	0.653
Tricuspid E/A ratio	0.79 ± 0.37	0.77 ± 0.13	0.493
Mitral E deceleration time (ms)	74 ± 28	66 ± 21	0.720
Tricuspid E deceleration time (ms)	69 ± 28	60 ± 15	0.298
Mitral E' (cm/s)	7.5 ± 1.3	6.9 ± 1.1	0.003
Tricuspid E' (cm/s)	8.4 ± 1.5	7.8 ± 1.0	0.023
Left isovolumic relaxation time (ms)	50 ± 11	49 ± 9	0.424

El remodelado cardiaco en gemelos concebidos por ART es similar a fetos únicos concebido por ART

Mecanismos que podrían explicar remodelado cardiaco

Factores intrínsecos a infertilidad paterna/materna

Manipulación de gametos y/o embriones

Condiciones de cultivo

Aumento en el riesgo de insulto

Objetivo: evaluar si remodelado cardiaco esta presente en fetos después de FET y compararlo con no-FET

Estudio prospectivo de 300 embarazos
100 SC, 100 FET y 100 no-FET
Se excluyo ovodonación, DGP y anomalías estructurales y cromosómicas
Evaluación ecocardiográfica a las 28-33 semanas

Table 1 Baseline and infertility characteristics of the study groups.

	SC (n = 100)	FET (n = 100)	Fresh ET (n = 100)
Maternal characteristics			
Age (year)	36.0 (33.8–38.5)	36.3 (33.9–38.8)	36.5 (34.5–38.6)
Body mass index (kg/m ²)	22.5 (20.5–24.7)	23.4 (20.6–25.7)	23.4 (21.2–26.0)
Smoking habit (%)	18	15	17
Caucasian (%)	81	81	86
Nulliparity (%)	54	74*	79*
Polycystic ovarian syndrome (%)	4	33*†	10
Paternal characteristics			
Age (year)	37.5 (34.2–41.5)	38.6 (35.4–41.6)	38.3 (36.7–40.8)
Body mass index (kg/m ²)	25.1 (23.4–27.1)	25.8 (23.6–28.4)	25.6 (23.9–28.0)
Smoking habit (%)	20	33	30
Caucasian (%)	74	79	87
Infertility and ART characteristics			
Infertility cause (%)			
Unexplained infertility		31	36
Endometriosis		8	13
Tubal factor		10	11
Male factor		56	44
Previous failed ET cycles (N)		0.7 (±0.9)	0.5 (±0.9)
Oocytes retrieved (N)		13 (10–17)†	8 (6–10)
Embryos obtained (N)**		9 (6–11)†	5 (3–6)
Transferred embryos (N)		1.8 (±0.6)	1.9 (±0.4)
ET at cleavage stage (%)		72	82

Table III Feto-placental data at scan.

	SC (n = 100)	FET (n = 100)	Fresh ET (n = 100)	P-value
Gestational age (weeks, days)	30,0 (28,5–33,6)	31,1 (29,1–32,6)	30,3 (29,4–31,5)	0.645
Estimated fetal weight (g)	1508 (1314–2028)	1652 (1415–1968)	1570 (1424–1895)	0.472
Estimated fetal weight centile	48 (22–80)	59 (18–79)	56 (22–75)	0.919
Cerebroplacental ratio (z-score)	−0.24 (±1.07)	−0.09 (±0.97)	0.03 (±1.09)	0.223
Ductus venosus PI (z-score)	−0.49 (−1.15–0.09)	−0.80 (−1.43–0.12)	−0.53 (−1.06–0.14)	0.329

Data are mean (± SD) or median (interquartile range).

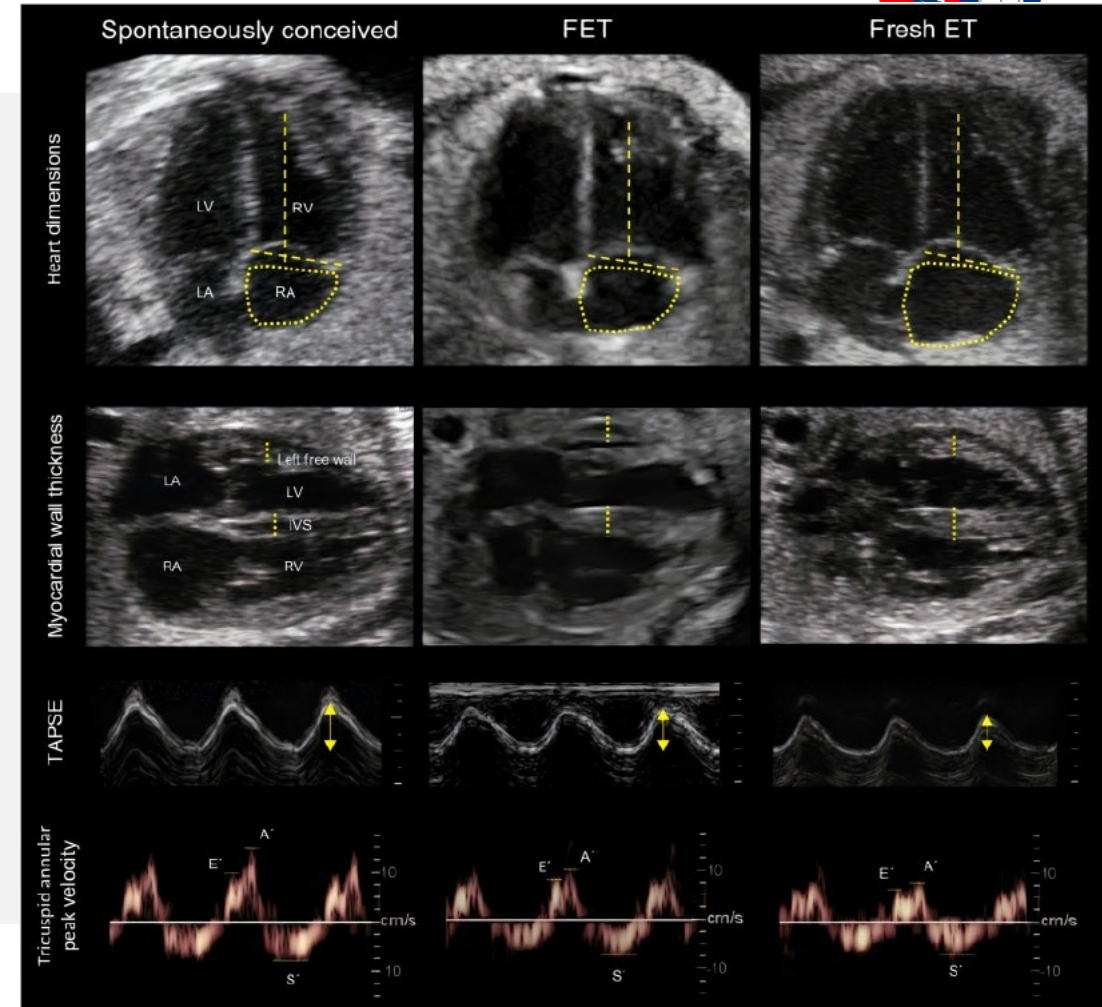
SC, spontaneously conceived pregnancies; FET, frozen embryo transfer; ET, embryo transfer, PI, pulsatility index.



Tanto FET como fresh ET mostraron signos significativos de remodelación y disfunción cardíaca

↑ tamaño cardíaco, ↑ grosor miocárdico y ventrículos mas esféricos

Menor FE y SF de VI y signos de disfunción diastólica



Fetos derivados de FET mostraron cambios mas leves que fresh-ET

¿Por qué la diferencia?

Mejor selección de embriones

Menor exposición a hiperestimulación
ovárica

Otras complicaciones que afectan
remodelación cardiaca

Summary of recommendations		
Number	Recommendations	GRADE
1	We suggest that genetic counseling be offered to all patients undergoing or who have undergone IVF, with or without ICSI.	2C
2	Regardless of whether PGT has been performed, we recommend that all patients who have achieved pregnancy with IVF be offered the options of prenatal genetic screening and diagnostic testing via chorionic villus sampling or amniocentesis.	1C
3	We recommend that the accuracy of first-trimester screening tests, including cfDNA for aneuploidy, be discussed with patients undergoing or who have undergone IVF.	1A
4	When multifetal pregnancies do occur, we recommend that counseling be offered regarding the option of multifetal pregnancy reduction.	1C
5	We recommend that a detailed obstetrical ultrasound examination (CPT 76811) be performed for pregnancies achieved with IVF and ICSI.	1B
6	We suggest that fetal echocardiography be offered to patients with pregnancies achieved with IVF and ICSI.	2C
7	We recommend that a careful examination of the placental location, placental shape, and cord insertion site be performed at the time of the detailed fetal anatomy ultrasound, including evaluation for vasa previa.	1B
8	Although visualization of the cervix at the 18 0/7 to 22 6/7 weeks of gestation anatomy assessment with either a transabdominal or endovaginal approach is recommended, we do not recommend serial cervical length assessment as a routine practice for pregnancies achieved with IVF.	1C
9	We suggest that an assessment of fetal growth be performed in the third trimester for pregnancies achieved with IVF; however, serial growth ultrasounds are not recommended for the sole indication of IVF.	2B
10	We do not recommend low-dose aspirin for patients with pregnancies achieved with IVF as the sole indication for preeclampsia prophylaxis; however, if one or more additional risk factors are present, low-dose aspirin is recommended.	1B
11	Given the increased risk for stillbirth, we suggest weekly antenatal fetal surveillance beginning by 36 0/7 weeks of gestation for pregnancies achieved with IVF.	2C
12	In the absence of studies focused specifically on timing of delivery for pregnancies achieved with IVF, we recommend shared decision-making between patients and healthcare providers when considering induction of labor at 39 weeks of gestation.	1C

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La remodelación cardiaca fetal es un fenómeno ya asociado a varias condiciones prenatales

El embarazo por ART provoca remodelado cardiaco fetal

El remodelado se caracteriza por mayor tamaño auricular, ventrículos más globulares y engrosados. Además de signos de disfunción sistólica/diastólica

Al parecer este remodelado no persiste en la vida postnatal, pero se requieren mayores estudios para establecer su verdadero impacto

CERPO

Centro de Referencia Perinatal Oriente
Facultad de Medicina, Universidad de Chile



REMODELACIÓN CARDIACA EN FETOS CONCEBIDOS POR TECNOLOGIAS DE REPRODUCCIÓN ASISTIDA

Alejandro Rojas Senzano

Programa de formación medicina materno fetal

Universidad de Chile