FISIOLOGIA CARDIOVASCOLARE IN GRAVIDANZA:ANALISI ECOCARDIOGRAFICA

DANIELA PAVAN, S .VITO AL TAGLIAMENTO, PORDENONE

- Modifiche significative di:

- preload
- afterload

Tutti gli studi concordano su:

- Aumento della portata
- Riduzione delle resistenze vascolari periferiche

Portata cardiaca:

- -aumenta durante le prime settimane

- plateau intorno alla 20° settimana successivamente stabile fino al parto

- ritorno in condizioni basali a poche settimane

Aumento portata cardiaca

- Nelle prime settimane accompagnato da aumento della gittata sistolica

nell'ultimo trimestre prevale l'aumento della frequenza cardiaca: il ritorno venoso è ostacolato dalla compressione dell'utero sulla v. cava

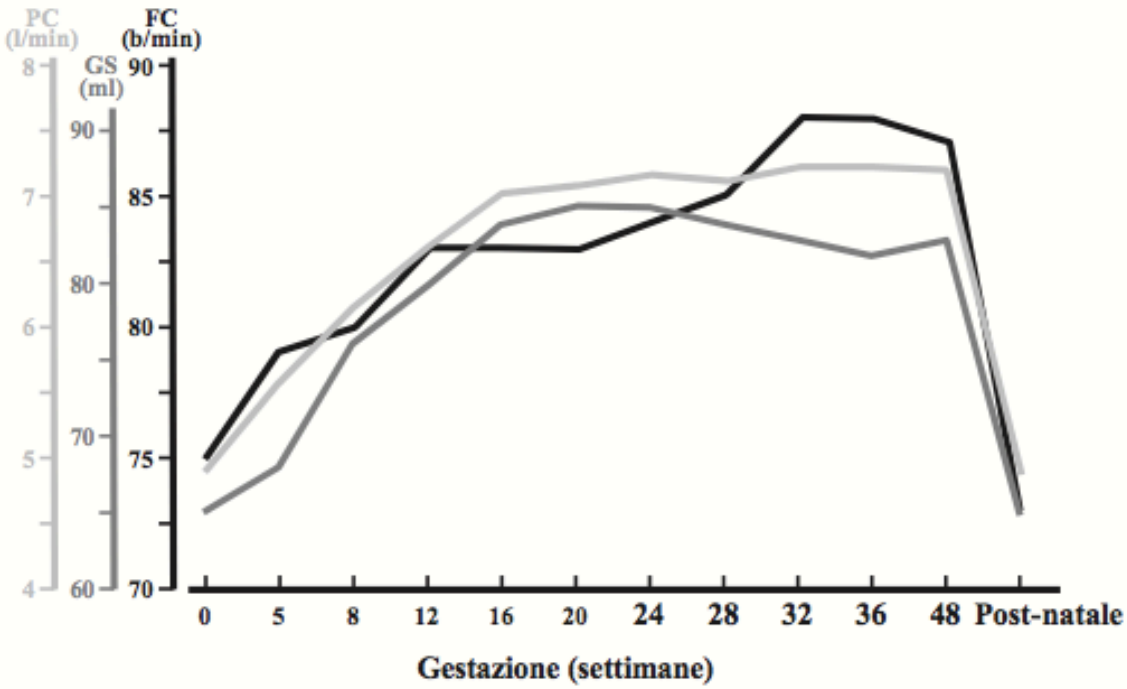
Aumento della portata cardiaca

- Transitorio ma significativo durante il travaglio : 30-50%

  quando vi sono le contrazioni uterine

Resistenze periferiche pressione arteriosa

- Tendono a calare progressivamente



ficazioni circolatorie indotte dalla gravidanza. FC = frequenza cardiaca; GS = gittata sistolica; PC = portata cardia cata.

Da: Melandri G: G Ital Cardiol 2008, 9(6):384-393

Figure 1 Increase in cardiac output from the non-pregnancy state throughout pregnancy. P-P, pre-pregnancy; PN, postnatal.

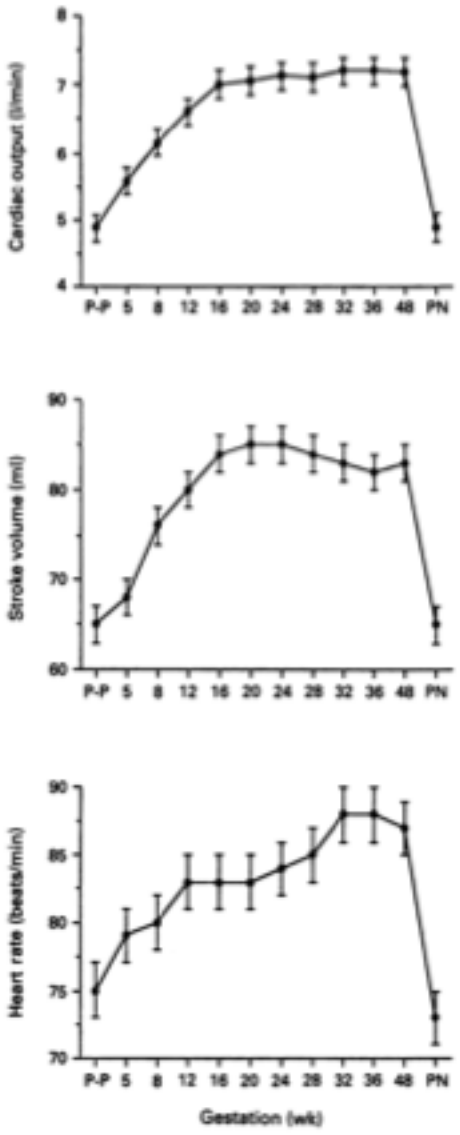
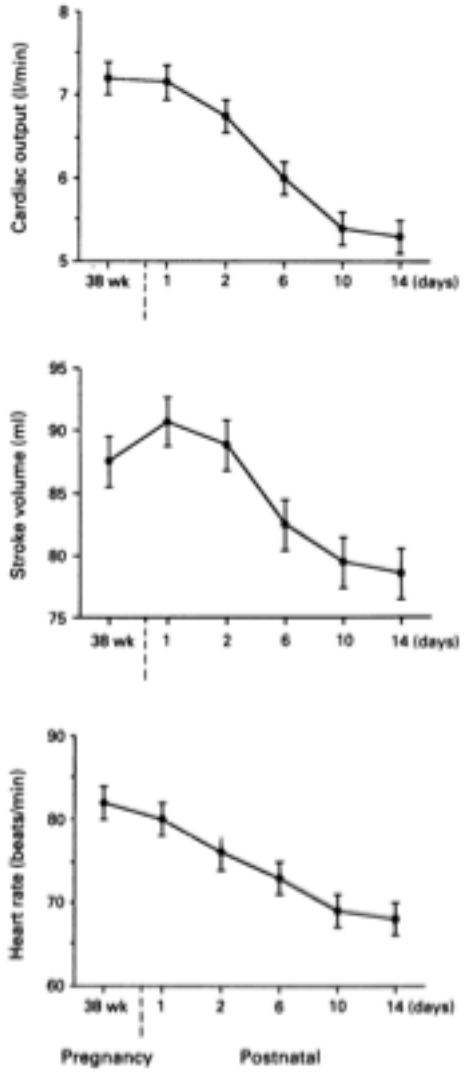


Figure 3 Changes in heart rate and cardiac output after normal delivery



Hunter S Br Heart J 1992

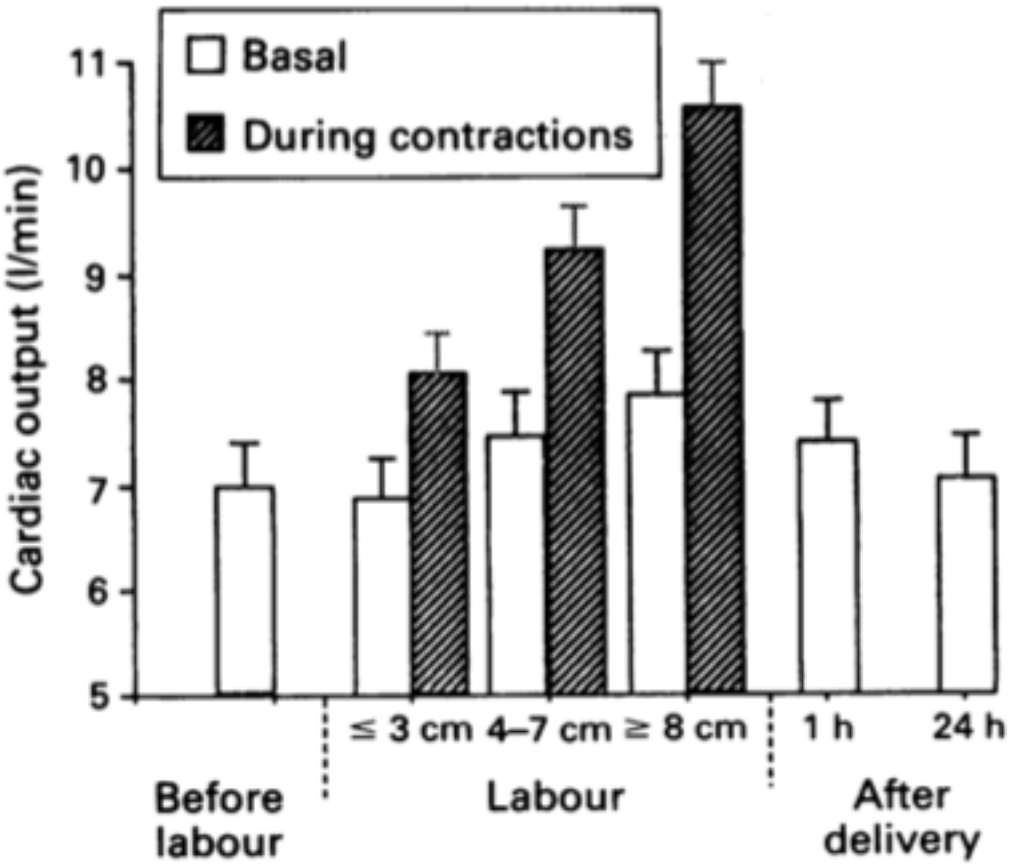


Figure 2 Changes in cardiac output and stroke volume during normal labour.

Hunter S Br Heart J 1992

Assorbimento farmaci

- Modificazioni della motilità e secrezione gastriche
- Aumento volemico e del volume di distribuzione modifica il legame con le proteine plasmatiche
- aumento del progesterone aumenta la clearance epatica
- aumento filtrazione glomerulare aumenta la clearance renale

Controversi:

- Andamento dimensioni
- Massa
- Volumi

Funzione miocardica

- Normale?
- Aumentata?
- Ridotta?

10. Schannwell C, Zimmermann T, Schneppenhein M, Plehn G, Marx R, Strauer BE. Left ventricular hypertrophy and diastolic dysfunction in healthy pregnant women. Cardiology. 2002;97:73-78.

11. Geva T, Mauer MB, Striker L, Kirshon B, Pivarnik JM. Effects of physiologic load of pregnancy on left ventricular contractility and remodeling. Am Heart J. 1997;133:53-59.

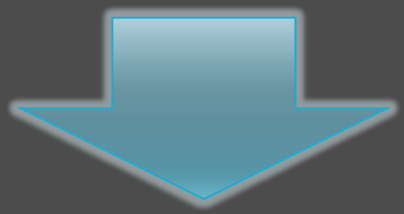
12. Gilson GJ, Samaan S, Crawford MH, Qualls CR, Curet LB. Changes in hemodynamics, ventricular remodeling and Ventricular Contractility during normal pregnancy: a longitudinal study. Obstet Gynecol. 1997;89:957-962.

- Eterogeneità casistica
- Razza
- Età gestazionale

- Metodologia di calcolo
- Variabilità

- Aumento del carico

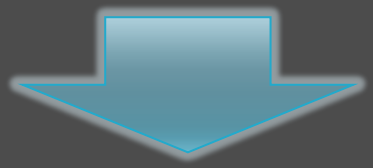
- modificazioni geometria



rimodellamento

- Sovraccarico di volume:

- dilatazione VS
- ipertrofia eccentrica
- modificazioni geometria (da elissoide a sferica)



Difficoltà a valutazione funzione VS sia con parametri tradizionali (EF , FS) che con i parametri di deformazione

Morphological and Functional Adaptation of the Maternal Heart during Pregnancy

Savu et al: Maternal Heart during Pregnancy

Oana Savu[1,2*], MD; Ruxandra Jurcut[2*], MD, PhD; Sorin Giusca[2], MD;
n van Mieghem[3], MD, PhD; Ilinca Gussi[4], MD, PhD; Bogdan A. Popescu[2,4], MD, Ph
Carmen Ginghina[2], MD, PhD; Frank Rademakers[1], MD, PhD;
Jan Deprest[3], MD, PhD; Jens-Uwe Voigt[1], MD, PhD

Circ res 2012; %:289-97

- 64 donne gravide arruolate in 2 istituti
  non cardiopatia associata
  non farmaci
  eco basale normale
  escluse gravidanze gemellari

  eco:
  1) 1° trimestre (12-14° settimana)
  2) 2° trimestre (22-24)
  3) 3° trimestre (32° settimana)
  4) 3-6 mesi post-partum

- valutazione parametri “convenzionali” (EF)

- deformazione miocardca (strain, strain rate))

Escluse per:

Finestra acustica: 4

Patologie : 5

Assenza di follow-up 4

51 donne età 30+/-3 (range 19-37 aa)

Vs 10 donne sane (non gravide): controllo

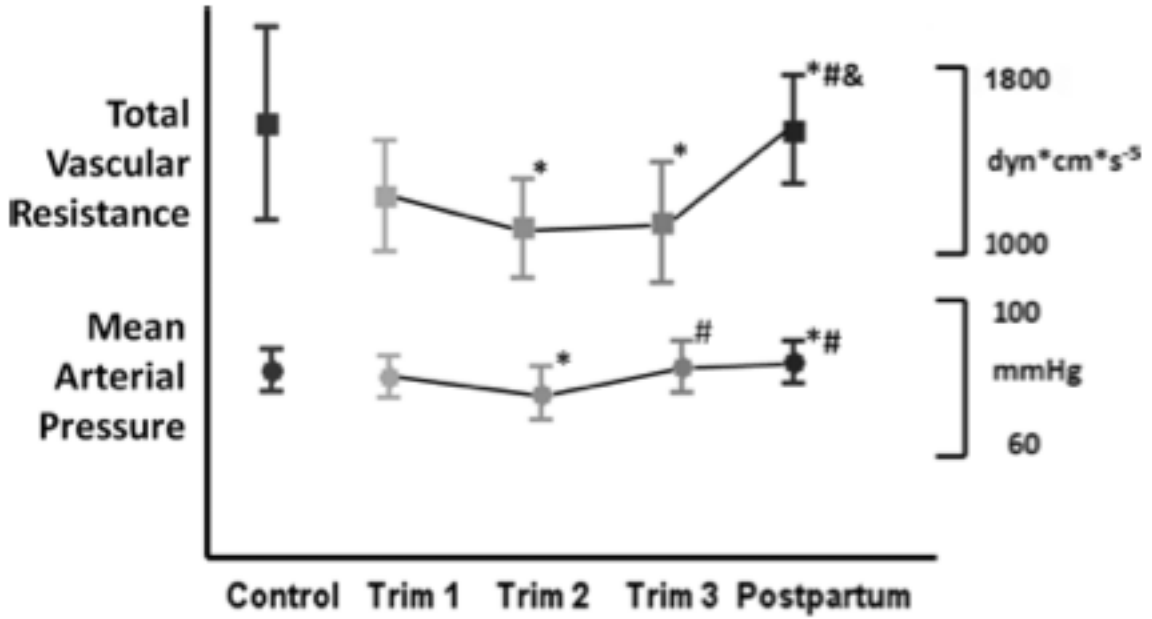


Figure 1. Course of mean arterial pressure and total vascular resistance during pregnancy and postpartum. Data are presented as mean±SD. Control indicates age-matched group of nonpregnant, healthy volunteers, and postpartum indicates data collection 3 to 6 months after delivery. Trim 1…3 indicates data collection during trimesters 1…3. *$P<0.05$ versus Trim 1. #$P<0.05$ versus Trim 2. &$P<0.05$ versus Trim 3.

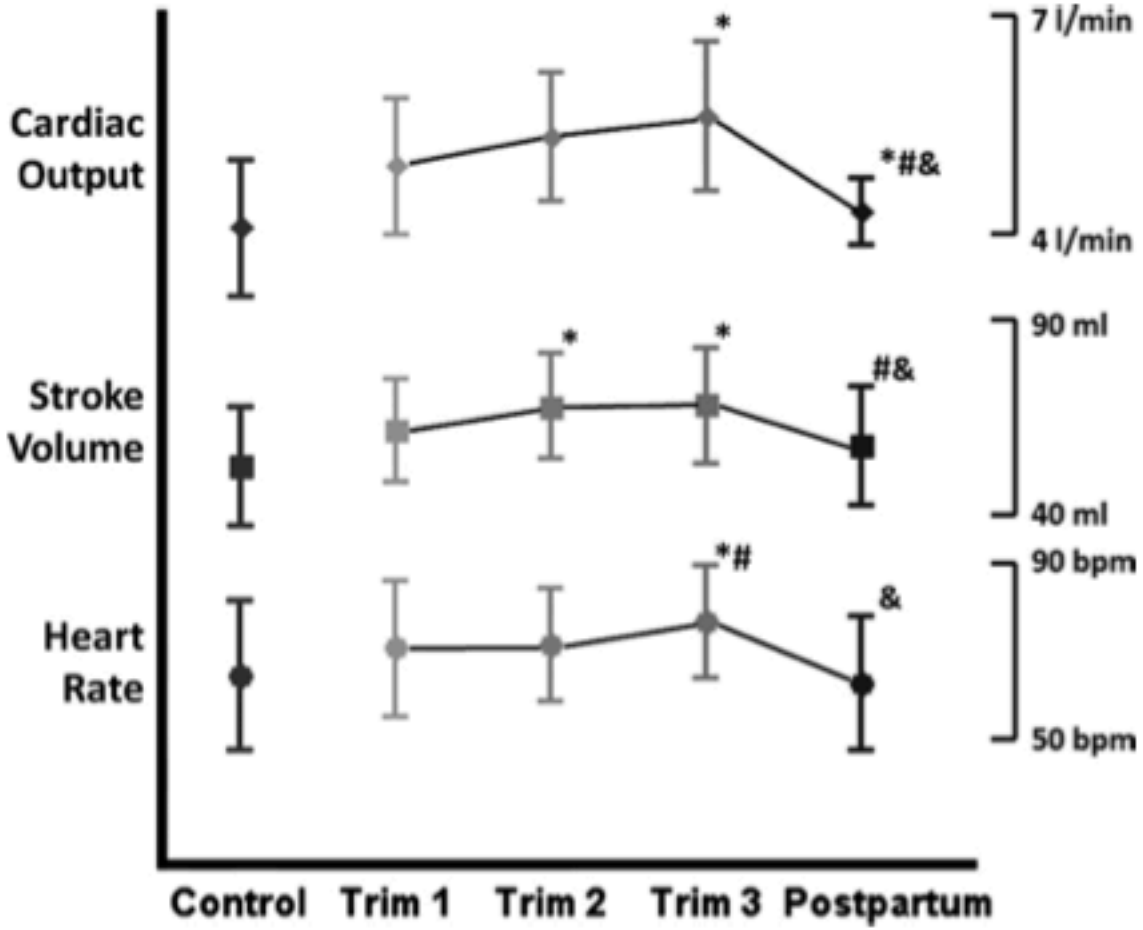


Figure 2. Cardiac output, stroke volume, and heart rate evolution during pregnancy. Data are presented as mean and 95% CI. Note the differential contribution of stroke volume and heart rate to the continuing increase in cardiac output. bpm indicates beats per minute; Trim, trimester. *$P<0.05$ versus Trim 1. #$P<0.05$ versus Trim 2. &$P<0.05$ versus Trim 3.

Table 2. Two-Dimensional Echocardiographic Parameters and Myocardial Velocities

Variable	Control	Trimester 1 (13 wk [12–16 wk])	Trimester 2 (23 wk [22–24 wk])	Trimester 3 (32 wk [32–33 wk])	Postpartum (4 mo [3–6 mo])	*P* Value*	*P* Value Control vs Postpartum
LVEDD, mm	43.5±3	45±3	47±3†	47±3†	46±2.5‡	<0.001	0.02/0.8§
LVESD, mm	26±2	28±3	29±2	30±3†‖	28±3‡	<0.001	0.11
RWT	0.37±0.04	0.36±0.05	0.37±0.03	0.38±0.04	0.35±0.04	0.047	0.1
LV mass, g	115±30	121±20	135±25†	151±27†‖	119±25‡‖	<0.001	0.68
Sphericity index	1.98±0.12	1.91±0.19	1.85±0.16†	1.71±0.17†‖	1.92±0.17‡	<0.001	0.35
LVEDV, mL	69±10	81±13	86±14†	92±14†‖	70±15†‡‖	<0.001	0.76
LVESV, mL	26±5	29±5	31±6	34±6†‖	25±7‡‖	<0.001	0.67
Ejection fraction, %	62±3	63±3	63±3	62±4	64±4	0.29	0.09
Shortening fraction, %	39±5	38±4	38±4	37±5	39±5	0.14	0.94
LA area, cm^2	15±2	16±3	18±2†	18±2†	15±3‡‖	0.001	0.75
MAPSE septal,¶ mm	14.4±1.1	16±1.5	15.6±1.5	14.1±1.3†‖	14.6±1.4†‖	<0.001	0.59
Peak myocardial systolic velocity, septum, cm/s	8.3±1	8.6±0.8	9±0.9	8.3±0.8‖	8.4±0.9‖	0.006	0.7

Data are presented as mean±SD. LVEDD indicates left ventricular end-diastolic diameter; LVESD, left ventricular end-systolic diameter; RWT, relative wall thickness; LVEDV, left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; LA, left atrium; MAPSE, mitral annulus plane systolic excursion.

*P values derived from linear mixed-effects model.

†$P<0.05$ vs trimester 1 using Bonferroni post hoc correction for repeated measurements.

‡$P<0.05$ vs trimester 3 using Bonferroni post hoc correction for repeated measurements.

§After body surface area adjustment.

‖$P<0.05$ vs trimester 2 using Bonferroni post hoc correction for repeated measurements.

¶MAPSE at the lateral mitral annulus and systolic myocardial velocities at this level behaved in a comparable way (data not shown).

output increased progressively during pregnancy because of

However, stroke work, as a parameter of global ventricular

Table 3. Longitudinal Strain and Strain Rate Evolution During Pregnancy

Variable	Control	Trimester 1 (13 wk [12–16 wk])	Trimester 2 (23 wk [22–24 wk])	Trimester 3 (32 wk [32–33 wk])	Postpartum (4 mo [3–6 mo])	*P* Value*	*P* Value Control vs Postpartum
Average systolic strain, %	−19.1±1.8	−19.5±2	−19.1±1.5	−17.6±1.6†‡	−19.5±2§	<0.001	0.58
Average systolic strain rate, s^{-1}	−1.14±0.1	−1.27±0.12	−1.21±0.13	−1.12±0.12†‡	−1.18±0.1	<0.001	0.40
Systolic strain apical segments, %	−19.6±2	−20±3	−19.4±2.5	−18.3±2.6†‡	−20.5±2.7§	0.005	0.35
Systolic strain mid segments, %	−19.4±2.4	−19.7±2.4	−19.3±2.6	−17.7±2.5†‡	−19.9±2.2§	<0.001	0.94
Systolic strain basal segments, %	−18.2±1.8	−18.8±2.5	−18.7±2.2	−17±2.4†‡	−18.3±2.5	0.002	0.53

Data are presented as mean±SD.

**P* values derived from linear mixed-effects model.

†$P<0.05$ vs trimester 1 using Bonferroni post hoc correction for repeated measurements.

‡$P<0.05$ vs trimester 2 using Bonferroni post hoc correction for repeated measurements.

§$P<0.05$ vs trimester 3 using Bonferroni post hoc correction for repeated measurements.

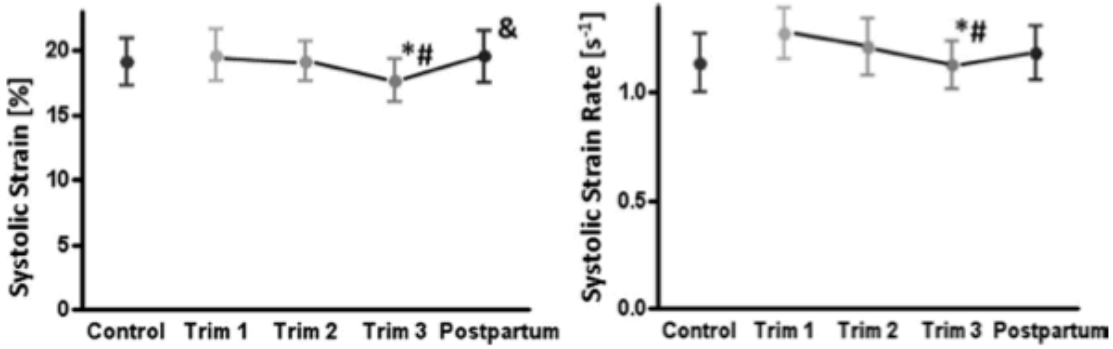


Figure 3. Evolution of longitudinal systolic strain and strain rate. Data are presented as mean±SD in absolute values. Trim indicates trimester. *P<0.05 versus Trim 1. #P<0.05 versus Trim 2. &P<0.05 versus Trim 3.

Table 4. Longitudinal Systolic Strain: Wall-by-Wall Analysis

Systolic Strain, %	Control	Trimester 1 (13 wk [12–16 wk])	Trimester 2 (23 wk [22–24 wk])	Trimester 3 (32 wk [32–33 wk])	Postpartum (4 mo [3–6 mo])	*P* Value*	*P* Value Control vs Postpartum
Inferoseptum	−20.7±2.6	−21.1±3.3	−19.9±3	−18±2.7†‡	−20.9±3§	0.001	0.68
Anterolateral	−18±3	−17.6±2.8	−18.1±3	−16.5±3	−17.5±3	0.08	0.67
Anterior	−19±2.6	−19.6±3	−20±3	−18.6±3	−21.3±3	0.03	0.90
Inferior	−19.6±2	−20.2±3	−20.0±3	−18.6±3	−21.3±3§	0.02	0.09
Inferolateral	−16.8±2.2	−18.4±3	−17.8±3	−16.5±3	−17.6±3.7	0.07	0.65
Anteroseptum	−19.9±2.2	−20.5±3	−18.9±3	−17.2±2.6†‡	−19.8±3§	0.001	0.71

Data are presented as mean±SD.

*P values derived from linear mixed-effects model.

†P<0.05 vs trimester 1 using Bonferroni post hoc correction for repeated measurements.

‡P<0.05 vs trimester 2 using Bonferroni post hoc correction for repeated measurements.

§P<0.05 vs trimester 3 using Bonferroni post hoc correction for repeated measurements.

Table 4. Longitudinal Systolic Strain: Wall-by-Wall Analysis

Systolic Strain, %	Control	Trimester 1 (13 wk [12–16 wk])	Trimester 2 (23 wk [22–24 wk])	Trimester 3 (32 wk [32–33 wk])	Postpartum (4 mo [3–6 mo])	*P* Value*	*P* Value Control vs Postpartum
Inferoseptum	−20.7±2.6	−21.1±3.3	−19.9±3	−18±2.7†‡	−20.9±3§	0.001	0.68
Anterolateral	−18±3	−17.6±2.8	−18.1±3	−16.5±3	−17.5±3	0.08	0.67
Anterior	−19±2.6	−19.6±3	−20±3	−18.6±3	−21.3±3	0.03	0.90
Inferior	−19.6±2	−20.2±3	−20.0±3	−18.6±3	−21.3±3§	0.02	0.09
Inferolateral	−16.8±2.2	−18.4±3	−17.8±3	−16.5±3	−17.6±3.7	0.07	0.65
Anteroseptum	−19.9±2.2	−20.5±3	−18.9±3	−17.2±2.6†‡	−19.8±3§	0.001	0.71

Data are presented as mean±SD.

**P* values derived from linear mixed-effects model.

†$P<0.05$ vs trimester 1 using Bonferroni post hoc correction for repeated measurements.

‡$P<0.05$ vs trimester 2 using Bonferroni post hoc correction for repeated measurements.

§$P<0.05$ vs trimester 3 using Bonferroni post hoc correction for repeated measurements.

load of the maternal heart driven by the necessity of the [illegible] the ventricular walls.

Table 5. RV Free Wall Deformation Parameters

Variable	Control	Trimester 1 (13 wk [12–16 wk])	Trimester 2 (23 wk [22–24 wk])	Trimester 3 (32 wk [32–33 wk])	Postpartum (4 mo [3–6 mo])	*P* Value*	*P* Value Control vs Postpartum
RV S, basal segment, %	−28.7±2.9	−30.2±7.1	−31.2±7.1	−28.1±7.5	−29.7±8.9	0.11	0.79
RV S, apical segment, %	−33.7±4.8	−35.4±7.5	−31.4±7.0	−28.2±6.7†	−32.9±7.4	0.001	0.68
RV SR, basal segment, s^{-1}	−1.38±0.32	−2.09±0.76	−1.97±0.6	−1.64±0.47†	−1.64±0.44†	0.008	0.19
RV SR, apical segment, s^{-1}	−1.91±0.37	−2.35±0.69	−2.13±0.6*	−1.79±0.45†	−2.17±0.5†	0.001	0.29
Average RV S, %	−31.2±2.4	−32.8±5.1	−31.3±5.1	−28.2±5.54†‡	−31.3±6.7	0.002	0.9
Average RV SR, s^{-1}	−1.64±0.24	−2.22±0.63	−2.05±0.44	−1.71±0.4†‡	−1.9±0.39	0.001	0.15

Data are presented as mean±SD. RV indicates right ventricular; S, strain; SR, strain rate.

**P* values derived from linear mixed-effects model.

†$P<0.05$ vs trimester 1 using Bonferroni post hoc correction for repeated measurements.

‡$P<0.05$ vs trimester 2 using Bonferroni post hoc correction for repeated measurements.

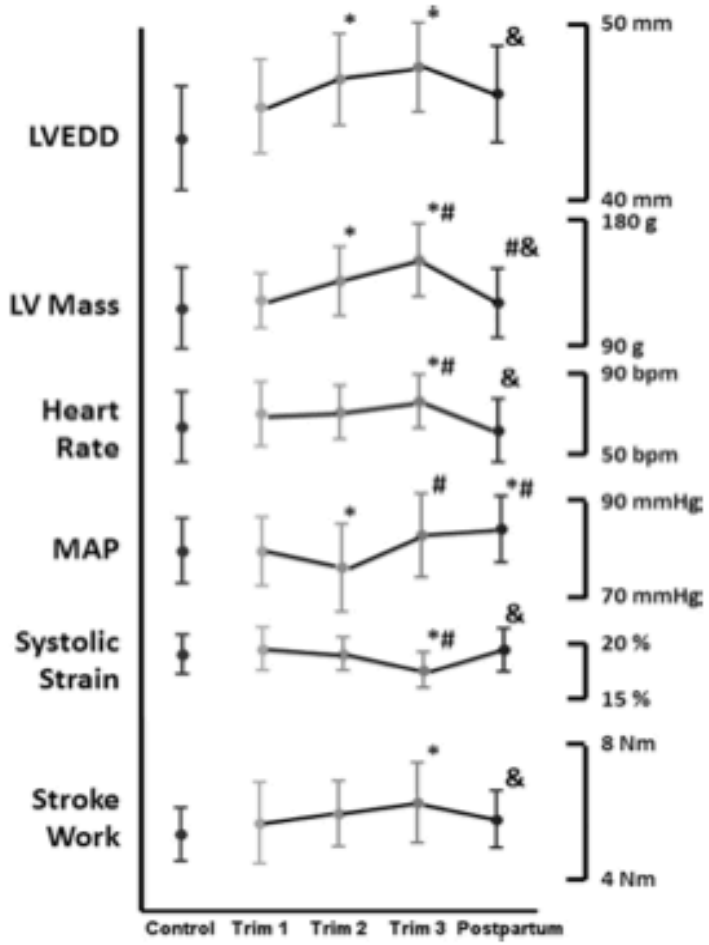


Figure 5. Evolution of hemodynamic and morphological parameters during pregnancy and postpartum. Data are presented as mean±SD. bpm indicates beats per minute; LV, left ventricular; LVEDD, left ventricular end-diastolic volume; MAP, mean arterial pressure; Trim, trimester; Nm, Newton meter. *$P<0.05$ versus Trim 1. #$P<0.05$ versus Trim 2. &$P<0.05$ versus Trim 3.

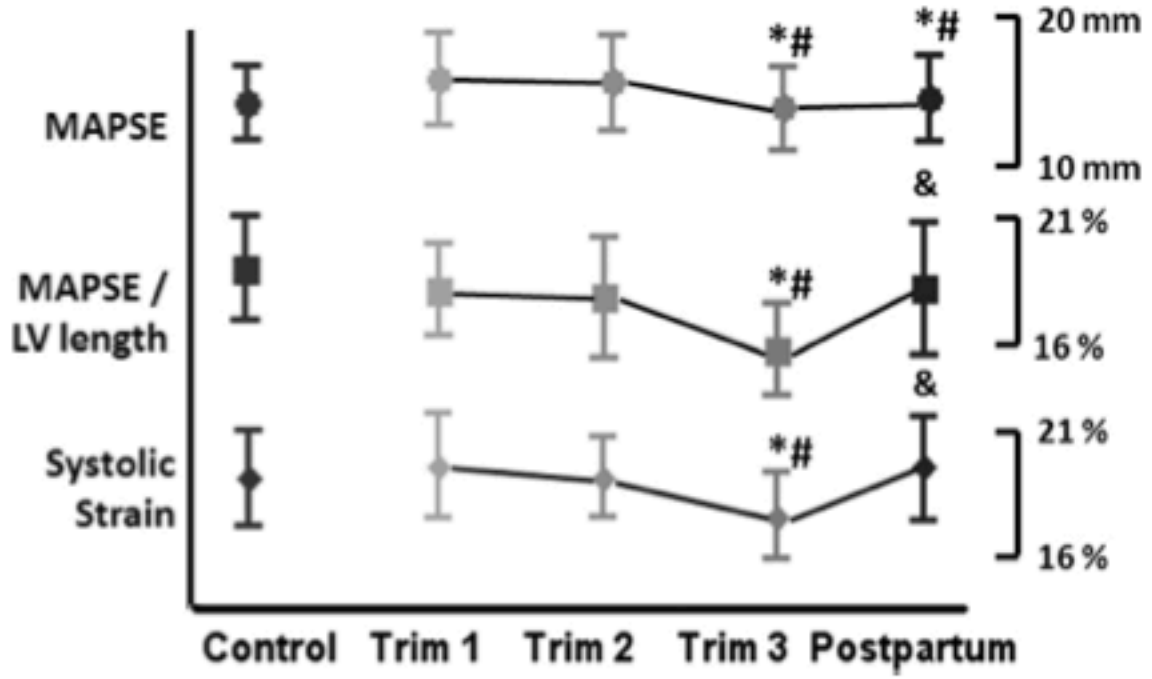


Figure 6. MAPSE and MAPSE adjusted for the LV length behavior during pregnancy and postpartum. Data are presented as mean±SD. Note that MAPSE remains decreased postpartum, whereas longitudinal strain and MAPSE adjusted for LV length return to the initial values, indicating the need for considering geometric changes while interpreting traditional functional parameters. LV indicates left ventricular; MAPSE, mitral annulus systolic excursion; Trim, trimester. *$P<0.05$ versus Trim 1. #$P<0.05$ versus Trim 2. &$P<0.05$ versus Trim 3.

Limiti:

- **Non disponibile esame pre-gravidanza**
- **Pb di allineamento fra fascio ultrasonoro e wall motion direction**
- **Fattibilità**
- **Assunzione che elasticità, orientamento delle fibre ecc siano costanti, non scontato in un contesto di importanti modifiche ormonali**

Cong et al. Cardiovascular Ultrasound 2015, 13:6
http://www.cardiovascularultrasound.com/content/13/1/6

CARDIOVASCULAR ULTRASOUND

RESEARCH Open Access

Structural and functional changes in maternal left ventricle during pregnancy: a three-dimensional speckle-tracking echocardiography study

Juan Cong[1,2,3,4], Tingpan Fan[1], Xiaoqian Yang[2,3,4], Jared Wynn Squires[5], Guomei Cheng[2,3,4], Linlin Zhang[3,4] and Zhan Zhang[2,3,4*]

- “2D ECHO e 3D speckle-traking

68 donne consecutive
Vs 30 controllo

1) 1 trimestre (12-14)
2) 2 trimestre (24-26)
3) 3 trimestre (36-38)
4) 6-9 settimane dopo il parto

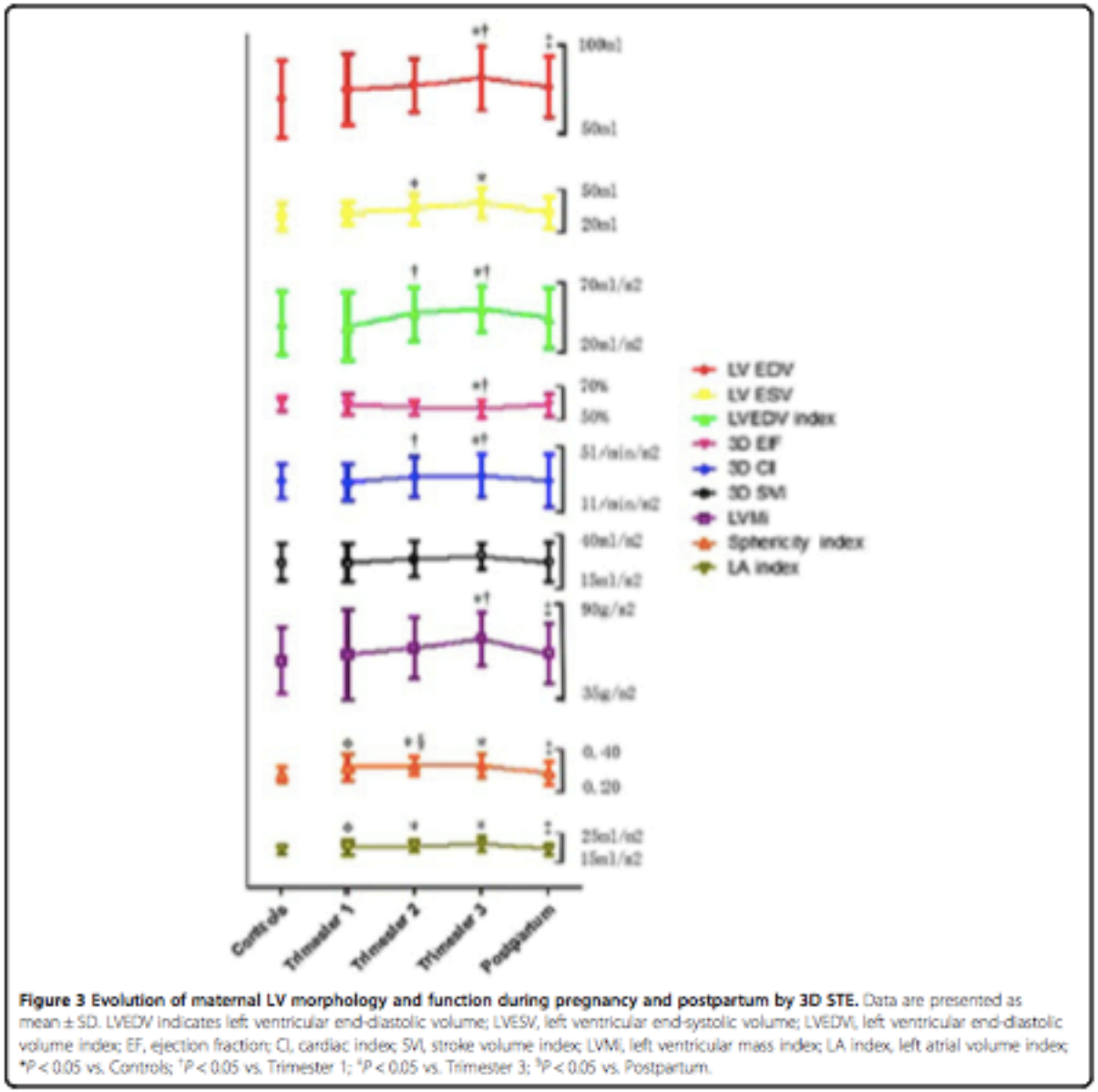


Figure 3 Evolution of maternal LV morphology and function during pregnancy and postpartum by 3D STE. Data are presented as mean ± SD. LVEDV indicates left ventricular end-diastolic volume; LVESV, left ventricular end-systolic volume; LVEDVI, left ventricular end-diastolic volume index; EF, ejection fraction; CI, cardiac index; SVI, stroke volume index; LVMI, left ventricular mass index; LA index, left atrial volume index; *$P < 0.05$ vs. Controls; †$P < 0.05$ vs. Trimester 1; ‡$P < 0.05$ vs. Trimester 3; §$P < 0.05$ vs. Postpartum.

Global Long Strain (GAS)
Global Circufer. Strain (GCS)
Global Area Strain GAS
Global Radial Strail GRS

Si riducono 3° trimestre
P <0.05

Correlano com età gestaz.
P <0.01

Global Area Strain GAS : associazione >>> con:

3D EF	r = 0.549
Sphericity index	r = 0,328
LV mass index	r = 0.22

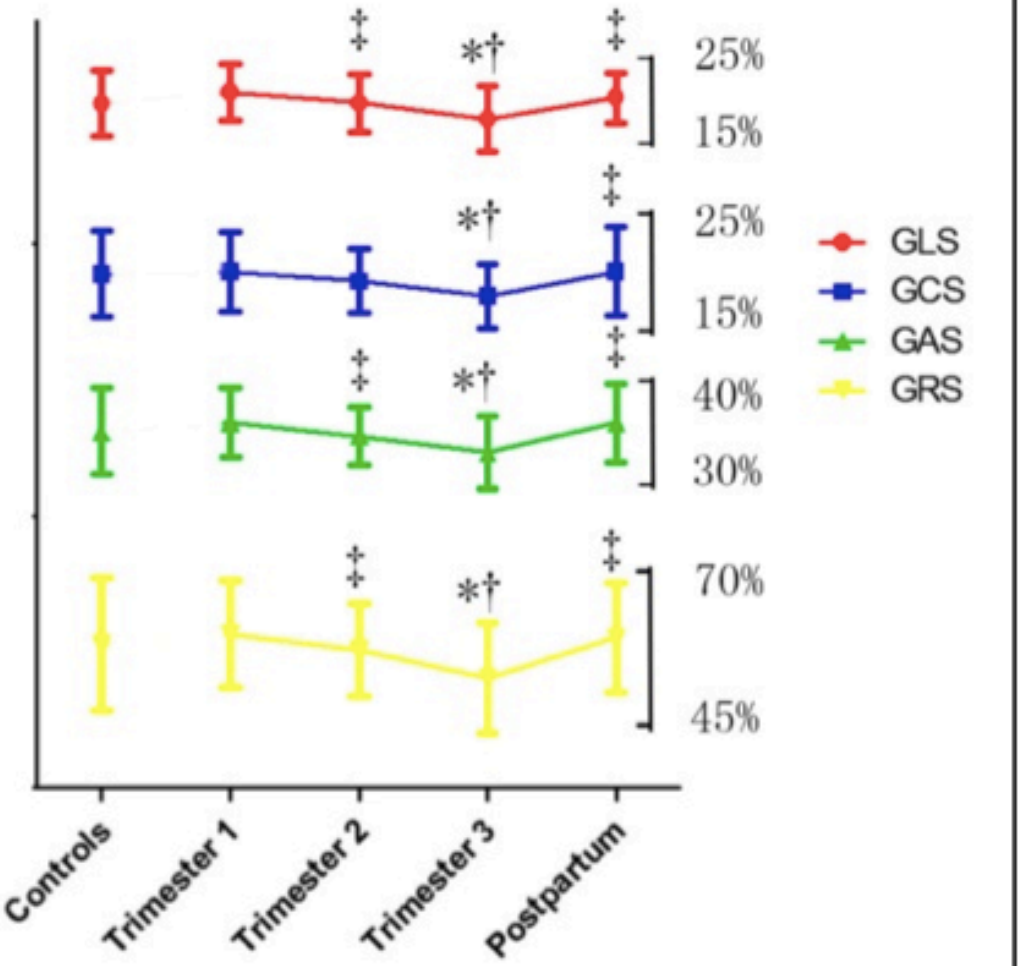


Figure 4 Assessment of myocardial deformation during pregnancy and postpartum by 3D STE. Data are presented as mean ± SD. Note that GLS, GCS, GRS and GAS decreased in Trimester 3, while returned in postpartum. GLS indicates global longitudinal strain; GCS, global circumferential strain; GAS, global area strain; GRS, global radial strain. *$P < 0.05$ vs. Controls; †$P < 0.05$ vs. Trimester 1; ‡$P < 0.05$ vs. Trimester 3; §$P < 0.05$ vs. Postpartum.

LIMITI:

- - studio “solo eco”
- - follow-up breve
- - da un punto di vista statistico: differenze piccole: overlap

- - speckle tracking condizionato da:
  qualità immagini
  frame rate basso
  vender specific

  ] accuratezza?

CONCLUSIONI

- Fisiologia complessa
- Ruolo ormonale
- Limitazioni ecocardiografia “tradizionale”
- Dati su speckle tracking promettenti ma casistiche limitate


www.windoweb.it