

# Cardio-Venous Communication Time

Time-interval between corresponding characteristics of maternal electrocardiogram and venous Doppler waves:  
A novel parameter in the study of venous hemodynamics during pregnancy

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## Introduction

- Pregnancy induces major adaptations of the maternal cardiovascular system
- blood volume expansion
  - decreased peripheral vascular resistance
- DUPLEX ULTRASONOGRAPHY (US) : useful to study changes of arterial and venous blood flow
- Venous Doppler waves (DW)= reflection of cardiac right atrial function (~jugular vein)
    - A wave = consequence of backflow resulting from right atrial contraction
    - X descent = forward venous flow following atrial relaxation
  - Maternal ECG
    - P wave = initiation of atrial contraction
    - QRS complex = simultaneous to atrial relaxation
  - Corresponding characteristics of venous DW and maternal ECG (figure 1)
    - A and P
    - X and R
  - Limitations in clinical practice: Atypical DW patterns trouble identification of DW characteristics
    - ? Solution → Addition of the maternal ECG?

## ECG and DW

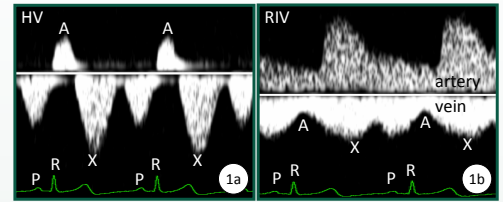


Figure 1  
 • a : typical DW of hepatic veins (HV)  
 • b : typical DW renal interlobar veins (RIV)  
 Intra-ECG and intra-DW time-intervals  
 • PP correspond with AA (corr.coeff.  $\geq 0.81$ )  
 • RR correspond with XX (corr.coeff.  $\geq 0.84$ )  
 → Used methodology = VALID

## Aims of the study

- Measurement of the time-interval between the maternal ECG and venous DW = Cardio-Venous Communication Time (CVCT) at the level of hepatic veins (HV) and renal interlobar veins (RIV) to
- (1) evaluate feasibility and sensibility of the combined ECG-DW methodology in hemodynamic studies
  - (2) evaluate RIV and HV CVCT at different stages of gestation.
  - (3) compare CVCT between Liver (L), Right Kidney (RK) and Left Kidney (LK).
  - (4) compare RIV and HV CVCT between Normal Pregnancy (NP) and Pre-Eclampsia (PE).

## Study population

- (1) NP at 10-14 weeks
  - (2) NP at 18-23 weeks
  - (3) NP at 28-33 weeks
  - (4) NP at  $\geq 37$  weeks (term)
  - (5) PE at 28-33 weeks
- Cross-sectional study in 5 groups of 10 pregnant women

## Combined ECG-DW methodology

- 3 consecutive venous DWs recorded simultaneously with ECG
  - each of the three main branches of HVs (L)
  - RIVs (both RK and LK)
- For each group, means and SD were calculated and compared statistically: conventional F-tests for linear mixed-effects models (SAS procedure MIXED)
- Time-interval between corresponding characteristics of maternal ECG and venous DW (figure 1)
- PA
  - PA/RR (with correction for gestation-induced changing heart rate)

## Study results (1)

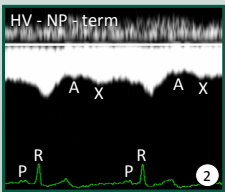


Figure 2: Atypical DW  $\neq$  figure 1a

Atypical HV patterns in this study

- (1) 20.00% (6/30)
- (2) 60.00% (18/30)
- (3) 86.67% (26/30)
- (term) 93.33% (28/30)

- (1 vs 2)  $p = 0.0043$   
 (2 vs 3)  $p = 0.0430$   
 (3 vs term)  $p = 0.6700$

- ECG facilitated identification of individual venous DW characteristics in atypical DW

### Discussion & Conclusion (1)

At advancing gestation:  
# atypical DW patterns  $\uparrow$

Simultaneous depiction of ECG and venous DW

- Feasible in hemodynamic studies
- Necessary to correctly identify venous DW characteristics

## Study results (2)

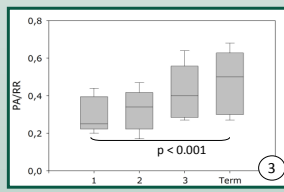


Figure 3 : PA/RR in HV at  $\neq$  gest. stages

- 1 vs term
    - PA :  $220 \pm 47$  vs  $337 \pm 74$  msec ( $p = 0.0008$ )
    - PA/RR :  $0.29 \pm 0.09$  vs  $0.48 \pm 0.15$  ( $p = 0.0009$ )
  - early, mid- and late gestation  $\sim$ 
    - PA & PA/RR gradually  $\uparrow$
- Similar results for RIV (not shown)

### Discussion & Conclusion (2)

CVCT in late > CVCT in early pregnancy

venous return needs more time to respond to cardiac stimuli with advancing gestation

gestational cardiovascular adaptation

Further studies:

- relate observed changes in CVCT to
- blood volume expansion and/or
- increased venous distensibility

## Study results (3)

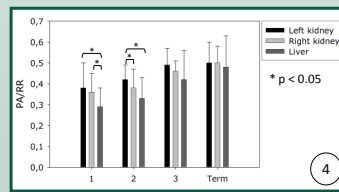


Figure 4 : PA/RR in  $\neq$  organs

- 1st trimester
- L vs RK :  $0.29 \pm 0.09$  vs  $0.36 \pm 0.09$  ( $p = 0.0137$ )
  - L vs LK :  $0.29 \pm 0.09$  vs  $0.38 \pm 0.12$  ( $p = 0.0129$ )

No significant differences observed in 3rd trimester or near term (figure 4)

### Discussion & Conclusion (3)

In early gestation

- CVCT shorter in L than in RK and LK

$\sim$

- typical vasculature of organ
- anatomical distance to the heart
  - liver = closer than kidneys

= characteristic of normal physiology

= gestation-dependent:  $\Delta$ CVCT disappears near term, probably due to maternal cardiovascular adaptation mechanisms (see above).

## Study results (4)

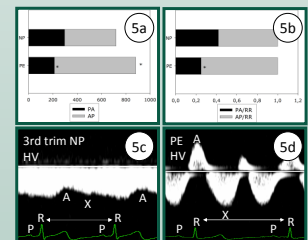


Figure 5 : HV : PA & PA/RR in PE vs NP

- Gest. age :  $32.96 \pm 5.06$  vs  $30.30 \pm 0.39$  ( $p = 0.1318$ )
- PA :  $213 \pm 68$  vs  $297 \pm 93$  msec ( $p = 0.0345$ )
- PA/RR :  $0.25 \pm 0.09$  vs  $0.42 \pm 0.14$  ( $p = 0.0042$ )
- RR :  $881 \pm 125$  vs  $717 \pm 115$  msec ( $p = 0.0068$ )

Similar results for RIV (not shown)

### Discussion & Conclusion (4)

CVCT shorter in PE than in NP

$\sim$

PE-related maternal cardiovascular maladaptation, i.e. a failure of vasodilatation  $\pm$  of volume expansion

Interference from medication in PE group cannot be excluded.

Combining ECG with Duplex Ultrasonography facilitates correct identification of venous Doppler wave (DW) characteristics.

The time-interval between ECG and DW, the so-called Cardio-Venous Communication Time (CVCT), is organ-specific and shows typical changes during normal and pathological pregnancy.

Our study illustrates that CVCT is a promising **new** parameter to study maternal venous hemodynamics.