Implications of IUGR-related heart geometric changes on electrophysiology: an *in silico* perspective

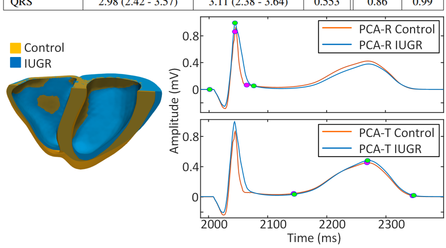
Freddy L. Bueno-Palomeque, Ernesto Zacur, Esther Pueyo, Fàtima Crispi, Pablo Laguna, and Ana Mincholé

University of Zaragoza, Zaragoza, Spain

Introduction: Ventricular remodeling due to intrauterine growth restriction (IUGR) results in a decreased sphericity index (SI), attributed to an increased left wall thickness and a reduced apex-base length. This study aims to assess how the reduced SI, caused by IUGR, affects electrophysiological properties, using biophysically detailed *in silico* models.

Methods: We used a computational biventricular model based on a realistic heart and torso model. To simulate the effects observed in IUGR subjects, we built a more globular model by reducing the base-to-apex length, enlarging the basal diameter and increasing the left wall thickness. Spatial principal component analysis was applied to the pseudo 12-lead ECG, to emphasize the QRS and T-wave separately. Wave delineation was then performed to measure QRS width, T_{pe}, and QT intervals and amplitudes, which were compared with previously reported clinical findings

	ECG data			Simulation	
	Control (n = 60)	IUGR (n = 33)	*p* value	Control	IUGR
$T_{pe,c}$ (s)	0.076 (0.074 - 0.081)	0.078 (0.076 - 0.083)	0.030	0.077	0.078
QT_c (s)	0.391 (0.376 - 0.406)	0.389 (0.381 - 0.399)	0.703	0.344	0.346
$T_{pe,c}/QT_c$ (s)	0.196 (0.188 - 0.207)	0.202 (0.196 - 0.212)	0.020	0.223	0.225
QRS width (s)	0.083 (0.074 - 0.089)	0.087 (0.081 - 0.090)	0.039	0.064	0.076
	Amplitude (mV)				
T-wave	0.82 (0.63 - 0.99)	0.77 (0.56 - 0.89)	0.318	0.45	0.48
QRS	2.98 (2.42 - 3.57)	3.11 (2.38 - 3.64)	0.553	0.86	0.99



QRS and T-wave markers at IUGR and control pseudo-ECG.

Results: The IUGR model exhibited a longer QRS width and a larger R-wave amplitude when compared to the control model in agreement with clinical findings. The simulated repolarization T_{pe} and QT intervals, and the ratio T_{pe}/QT did not show differences between the IUGR and control models. Clinical findings showed, however, increased T_{pe} and T_{pe}/QT in IUGR subjects.

Conclusion: The simulated reduction in SI and the widening of the left ventricular wall led to an increase in both the QRS width and the amplitude of the R-wave, aligning with clinical data. There was no impact on the QT interval, still consistent with clinical observations. While the geometric change resulting from IUGR impacted the QRS complex, the T_{pe}, QT, and T_{pe}/QT remained unchanged, suggesting ionic remodeling not considered in the simulation.