Vascular coupling induces synchronization, quasiperiodicity, and chaos in a nephron tree - DTU Orbit (10/12/2018)

Vascular coupling induces synchronization, quasiperiodicity, and chaos in a nephron tree

The paper presents a study of synchronization phenomena in a system of 22 nephrons supplied with blood from a common cortical radial artery. The nephrons are assumed to interact via hemodynamic and vascularly propagated coupling, both mediated by vascular connections. Using anatomic and physiological criteria, the nephrons are divided into groups: cortical nephrons and medullary nephrons with short, intermediate and long Henle loops. Within each of these groups the delay parameters of the internal feedback regulation are given a random component to represent the internephron variability. For parameters that generate simple limit cycle dynamics in the pressure and flow regulation of single nephrons, the ensemble of coupled nephrons showed steady state, quasiperiodic or chaotic dynamics, depending on the interaction strengths and the arterial blood pressure. When the solutions were either quasiperiodic or chaotic, cortical nephrons synchronized to a single frequency, but the longer medullary nephrons formed two clusters with different frequencies. Under no physiologically realistic combination of parameters did all nephrons assume a common frequency. Our results suggest a greater variability in the nephron dynamics than is apparent from measurements performed on cortical nephrons only. This variability may explain the development of chaotic dynamics in tubular pressure records from hypertensive rats. ©2007 American Institute of Physics

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