Synchronization of period-doubling oscillations in vascular coupled nephrons

The mechanisms by which the individual functional unit (nephron) of the kidney regulates the incoming blood flow give rise to a number of nonlinear dynamic phenomena, including period-doubling bifurcations and intra-nephron synchronization between two different oscillatory modes. Interaction between the nephrons produces complicated and time-dependent inter-nephron synchronization patterns. In order to understand the processes by which a pair of vascular coupled nephrons synchronize, the paper presents a detailed analysis of the bifurcations that occur at the threshold of synchronization. We show that, besides infinite cascades of saddle-node bifurcations, these transitions involve mutually connected cascades of torus and homoclinic bifurcations. To illustrate the broader range of occurrence of this bifurcation structure for coupled period-doubling systems, we show that a similar structure arises in a system of two coupled, non-identical Rossler oscillators. (C) 2011 American Institute of Physics. [doi: 10.1063/1.3641828]