Biomed Tech 2012; 57 (Suppl. 1) © 2012 by Walter de Gruyter · Berlin · Boston. DOI 10.1515/bmt-2012-4217

Transmission Line Model for Pulse Wave Analysis Accompanied on Experimental Measurements at a Human Model

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Introduction

Hypertension and diseases of the cardiovascular system are two major ailments from which every fifth human suffers, tendency increasing. For diagnostic purposes there already exists a variety of stationary equipment to measure blood pressure and blood volume flow. Additionally measurement techniques for long-term implants in the arterial cardiovascular system are subject of research. To increase the diagnostic output of combined measurements of pressure and flow a transmission line model to analyse the pulse wave distribution in human bodies is developed. In parallel, a model of the cardiovascular system is designed to verify applicability.

Methods

The experimental human model is controlled by the real time system CompactRio (NI) and consists of a pulsatile flow, cardiac valve and an arterial system made of glass and silicon tubes. Thereby each artery is completed by a flow sensor. At the places of aorta ascendis, artery brachialis and femoralis pressure and pulse wave sensors are implemented.
In the theoretical analysis in Simulink (Mathworks) of the pulse wave distribution every artery section (out of 36) is represented as an own transmission line section model (TLSM). A TLSM is built up to RLCG-Network as described by Olufsen 2004 and Rideout 1991. The material parameter are taken form the experimental human model.

Results

The flow, pressure and pulse wave sensors allow to generate the necessary signals in the human model similar to the signal detection tools in Simulink. The exact matching of the experimental material parameters lead to a good accordance of experimental model and simulation.

Conclusion

Key for the analysis of the pulse wave distribution is the detection of pressure variation in time by the pulse wave sensors which allows to follow the pulse wave in direction and amplitude. This is in conformance with the transmission line model.