Modelling of Artery's Part Mechanical Impedance

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Abstract - **In this work results of artery's part mechanical impedance simulation are presented** *Keywords* - **Medical diagnostics, sphygmic diagnostics, artery's part mechanical impedance.**

I. Introduction

Synchronic sphygmometry method is based on sphygmic signal registration from three parts of radial artery, placed along districts 3.9 cm. Artery's surface position causes uncertainness in estimations of signal influence through the human organism bio structures. The aim of work was to simulate artery's part mechanical impedance as a signal source.

II. Investigation results

In common case mechanical impedance of bio structure has complex character, but for sphygmometry it is determined by environment's elastic properties and can be described by rigidity K. In work [2] elastic properties of artery's wall were modelled by rigidity K, which in case of external pressure are described by formula $K = a + b\cdot(P_d\text{-}P_e)^2$, where a,b are constants, P_d – diastolic pressure in artery, P_e- external pressure. This formula has stationary point P_d-P_e, matching minimum of rigidity. But this model doesn't coincide with well known experimental results- maximum value of pulse signal on conditions that pressure in artery is equal to average dynamic pressure of blood.

This fact shows necessity of model developing for artery's elasticity simulation, which is signal source for sphygmometry method.

Elasticity K_P for artery's part was calculated in [3] using experimental data by formula:

$$K_p = \frac{F_p}{x_p} = 2\cdot p\cdot l\cdot\frac{\Delta P}{\Delta V/V}\ , (1)$$

where F- force of pressure pulse causes shift of vascular wall $x_p = r\cdot\Delta V/\pi\cdot V$, ΔV - sphygmic changes in linear approximation, P – dynamic pressure of blood. In formula (1) V is artery's part volume corresponded with diastolic pressure of blood, and ΔV,ΔP –sphygmic changing of values.

Because experimental data in [3] was presented as a dependence between the artery's volume changing and transmural pressure, value K_p can be calculated from expression:

$$K_p = 2\cdot p\cdot l\cdot\frac{\Delta P}{D},\ D = \frac{a_2 - a_1}{1 + a_1},\ a_1 = \frac{V_d - V_0}{V_0},\ a_2 = \frac{V_s - V_0}{V_0}\ , (2)$$

where V_a, V_d, V_s, –accordingly initial, diastolic, systolic pressure in artery. Evaluation results were approximated by functions $K = a + b\cdot(P_d\text{-}P_e)^2$ (3a) and $K = a + b_1\cdot(P_d\text{-}P_e) + d\cdot(P_d\text{-}P_e)^2$ (3b). On fig.1 results for artery's part with length 10 cm and sphygmic pressure value 40 mmHg were shown. Function $K = a + b_1\cdot P_d + d\cdot P_d^2$ gave more accurate results for experimental data from [3] and was chosen for next investigations and analyzing. Function (3b) had stationary point corresponded with minimum $P_e = P_d + \dfrac{b_1}{2\cdot d}$

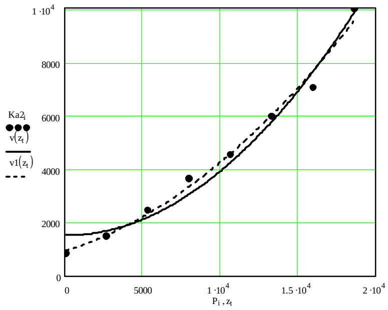

Fig.1 Evaluation results (points) and their approximations () by functions $K_P = K_P(P_d)$..

III. Conclusion

Investigation results proved underdevelopment of known model for artery's mechanical impedance [2]. Approximation results for artery's part rigidity by 2nd order polynomial had qualitative matching with experimental data for initial, diastolic, systolic pressure in artery, but quantitative assessment proved to be overestimated. Further inquiry provides development of model for bio system signal forming, able to explain and remove uncertainty.

References

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