AN ISCHEMIC DISEASE CLASSIFICATION OF LOWER LIMBS

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Abstract

An ischemic disease of lower limbs is a manifestation of general arteriosclerosis. Its early noninvasive diagnostic is possible using the approach of the Doppler measurement of the blood flow in the vessels with following classification by a neural network expert system.

Keywords

classification, biosignal, neural network, Doppler measurement, lower limbs

1. Introduction

The diagnostic of ischemic disease of lower limbs in its evolved stage is possible by invasive and also noninvasive approaches. The signification or the goal of our project was the clinical verification of the classification algorithm evaluating the biosignals scanned exclusively through the noninvasive approach.

The clinical verification was performed on the patients by the method of digital subtraction angiography (DSA). The control group was created from probands in the age of 22 - 26 years.

2. Biosignal acquisition and processing

Scanning of all relevant biosignals was performed by the diagnostic system IMEXLAB 9000, which applies these diagnostic methods:

- ultrasound Doppler blood flow velocity measurement,
- pletysmografic measurement,
- systolic pressure measurement in specific spots of arterial system.

Digital thermometer YSI 4600 was used for the measurement of skin temperature. The measurements were performed in the Faculty Hospital Brno Bohunice on the functional diagnostic clinic before surgery reconstruction by a competent angiologist.

Typical progress of arterial blood flow velocities obtained through ultrasound Doppler velocity measurement (AVG signal) is displayed in fig. 1.
Working frequencies were: f = 5 or 8 MHz

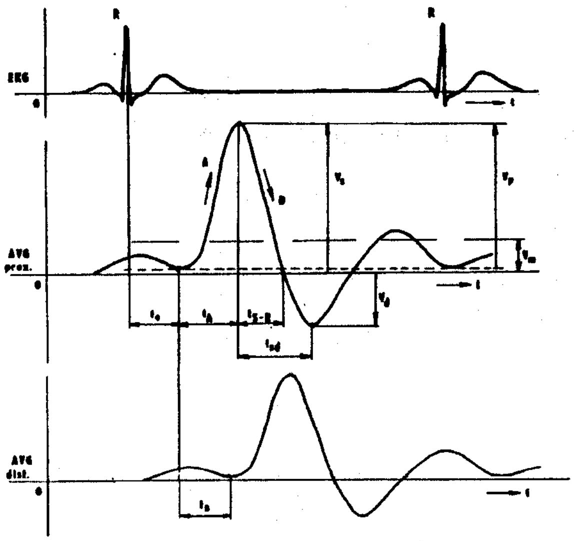

Fig. 1. Typical AVG signal

Analogue signals were digitized by A/D converter DASH - 8, averaged from 5 contiguous cardio cycles. Typical measurement spots were: AI (arteria iliaca), AF (arteria femoralis superficialis), AP (arteria poplitea), ATA (arteria tibialis anterior), ATP (arteria tibialis posterior), fig. 2.

Relevant parameters were screened in every measurement spot. Such as, [1]:

- pulsatility index PI

$$PI = \frac{v_S - v_D}{v_m},$$

- damping factor DF

$$DF = \frac{PI_{prox}}{PI_{distal}},$$

- blood pressure index BPI (systolic)

$$BPI = \frac{BP_{perif}}{BP_{a.brach}},$$

- coefficient of change of pulsality wave KVP

$$KVP = \frac{T_V}{T_P - T_V},$$

- inclination time Ti.

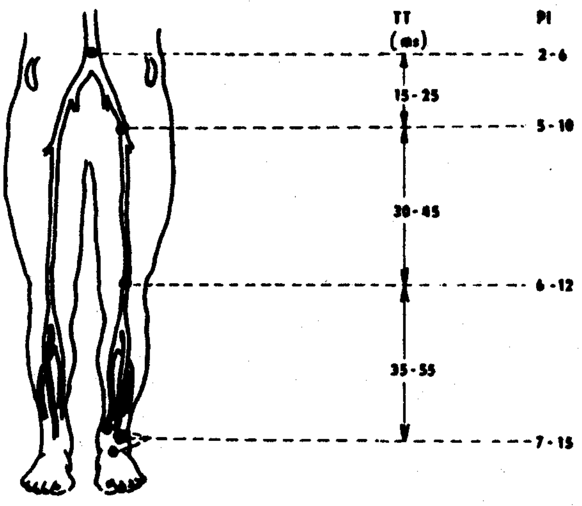

Fig. 2.: Typical measurement spots

3. Classification algorithm

Applied classification algorithm is based on neural network expert system NEUREX, version 5.1, [2]. Under optimal condition is the topology of neural network considered to be: N 54 - 30 -20 -10 -3, when three hidden layers (30-20-10) for 54 entry parameters and 3 resultant classification ranks were used.

4. Conclusions

The attained results fully affirmed our presumptions and demonstrate the noninvasive diagnostics to be implementable according to our methodology. The indisputable asset of our work is the creation of the angiograficaly verified biosignal database gained through noninvasive diagnostical approaches.

Classification process of the arterial system of the whole lower limb is fully original. Each tested object (limb) was classified with 54 parameters for 3 class of objects : health - stenosis- plugs.

In overall view 124 people were tested and from among them 94 patients (in the age of 37 - 82 years) and 30 probands of the control group (22-26 years). Reached sensitivity and specification to DSA was 95,2% or respectively 70,6%.

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