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### RESEARCH ARTICLE

#### HEMODYNAMIC INDEXES, REGISTERED IN YOUNG SUBJECTS WITH HIGH NORMAL BLOOD PRESSURE.

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hemodynamic indices; high normal arterial pressure; microcirculation.

#### Abstract

The goal of the study was to examine microcirculation and the hemodynamic profile in individuals with high normal arterial pressure (HNAP). The object of the investigation is focused on young individuals from 18 to 35 years with HNAP. The two following groups – with HNAP and with optimal normal arterial pressure (ONBP) are formed, based on inquiry and screening arterial pressure measurement among 109 individuals (49 men and 60 women). Non invasive native capillaroscopy and anthropometric examination, arterial pressure monitoring and non invasive bio impedance cardiography were carried out.

**Results:** Significantly higher crossed capillaries percentage ( $22.34 \pm 13.07$ ,  $p < 0.05$ ) is registered in HNAP group compared to the controls –  $16.36 \pm 16.64$ . Cardiac output /cardiac index ratio and velocity index were increased in HNAP, as well as mean arterial pressure. Conclusion: hemodynamic evaluations in HNAP group are close to these in hypertensive individuals.

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#### Introduction:

Elevated arterial blood pressure (ABP) is an important cardiovascular risk factor for cardiovascular morbidity and mortality worldwide [1]. The European Society of Cardiology (ESC) defines ABP values under 140/90 mmHg in three categories - optimal (under 120/80 mmHg), normal (120-129 mmHg for systolic and/or 80-84 mmHg for diastolic) and high normal (130-139 mmHg for systolic and/or 85-89 mmHg for diastolic) in concern with the risk of cardiovascular disease or stroke to appear following arterial blood pressure abnormalities [2,3]. The risk, arterial hypertension (AH) to develop is higher in individuals with high normal ABP (HNAP) [4,5,6,7,8], as it is considered to be characterised by endothelial activation and metabolic changes [9,10]. Native capillaroscopy is a non invasive method allowing direct visualization of the nutritive dermal blood vessels in vivo. Bioimpedance cardiography (BIC) is based on electrical voltage changes registration in the thoracic region, giving information about the hemodynamics [16, 17, 18, 19].

#### Aim:

The goal of the study was to examine microcirculation and to follow the hemodynamic profile in young HNAP individuals with non invasive techniques.

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**Methods:**

After measuring ABP, recorded four times at 3 min intervals using Argus LCM plus, Shiller device, among 109 individuals at age of  $20 \pm 1.3$  years (49 men and 60 women), two groups were formed: HNAP,  $n=50$  and control with optimal ABP (ONAP),  $n=59$ .

The protocol of the study for both of the groups was:

1. Native capillaroscopy (Capillaroscope JH1005, PRC), magnification  $\times 250$ ;
2. Anthropometric examination with Guangzhou ZYS Electric CO, Ltd, PRC;
3. Five minutes recording of ABP by CNAP "HD" (Biopac Instruments, USA) [13,14,15];
4. Five minutes bioimpedance cardiography by NICO-100C (Biopac Instruments, USA).

The study was approved by the Medical University- Plovdiv's medical ethics committee (protocol 4/16.06, 2016).

**The followed up parameters were:**

Mean arterial / venous capillary diameter (a/v);

Number of capillaries;

Crossed capillaries, (%);

Abnormal capillaries, (%);

Body Mass Index (BMI= $\text{kg}/\text{m}^2$ ) [11, 12];

Visceral fat index (VFI  $\text{kg}/\text{m}^2$ );

Basal metabolic rate (BMR Kcal/d);

Fat free mass index (FFMI  $\text{kg}/\text{m}^2$ );

Metabolic age (years).

The hemodynamic indices, followed up by BIC ,CNAP and capillaroscopic parameters are presented in details in table 2.

The data were statistically processed by SPSS 16 package - descriptive analysis and paired t-test was used.

**Results:**

Significantly higher crossed capillaries percentage ( $22.34 \pm 13.07$ ,  $p < 0.05$ ) is registered in HNAP group compared to the control one – ( $16.36 \pm 16.64$ ), fig.1.

Significantly higher are BMI ( $23.45 \pm 4.25$   $p < 0.01$ ), VFI ( $6.73 \pm 5.51$   $p < 0.01$ ), FFMI ( $18.04 \pm 2.19$   $p < 0.01$ ), BMR ( $1731.94 \pm 344.59$   $p < 0.01$ ) and Metabolic age ( $22.14 \pm 6.24$   $p < 0.01$ ) in HNAP compared to the controls BMI ( $20.83 \pm 5.17$ ), VFI ( $2.89 \pm 1.83$ ), FFMI ( $15.75 \pm 1.38$ ), BMR ( $1435.51 \pm 255.84$ ) and metabolic age ( $20.42 \pm 3.95$ ) (table 1). The MBP was higher ( $96.36 \pm 9.09$   $p < 0.05$ ) compared to the controls ( $83.43 \pm 6.87$ ). The mean values of velocity index ,VI ( $0.05 \pm 0.1$ ,  $p < 0.05$ ) and cardiac output/cardiac index ratio, CO/CI ( $1.86 \pm 0.26$ ,  $p < 0.05$ ) are significantly higher in HNAP in comparison to ONAP group, ( $0.04 \pm 0.01$ ), ( $1.65 \pm 0.17$ ) respectively. Vascular resistance shows tendency of increasing in HNAP individuals, compared to ONAP group (table2).

**Discussion:**

We do not find vascular capillary remodeling (a/v changes) and capillary rarefaction in HNAB group, followed by us (table 2), as it is commented in the literature [20, 21, 23]. Increased crossed capillaries [22] and abnormal capillaries are registered in HNAP. Our results confirm the importance of overweight on the risk arterial hypertension to develop. In this regard, the risk profile correction in HNAP objects will prevent the AH appearance [24, 25, 26]. In HNAP were increased CO/CI ratio and VI, as well was MBP [27].

**Conclusion:**

The microcirculatory changes in young individuals with HNAP show prevailing morphological changes.

The hemodynamic evaluation in HNAP is close to that in the hypertensive individuals as it is commented in the literature[28]. The recommendations would be directed to changes in lifestyle - risk profile correction and increased physical activity would delay AH appearance.

**Table 1:** Anthropometric analysis in ONAP and HNAP groups.

Groups Parameters	ONAP Mean± SD N =50	HNAP Mean± SD N =44	P
<b>BMI</b> ( kg/m <sup>2</sup> )	20.83±5.17	23.45±4.25	<0.01**
<b>VFI</b> ( kg/m <sup>2</sup> )	2.89±1.83	6.73±5.51	<0.01**
<b>FFMI</b> ( kg/m <sup>2</sup> )	15.75±1.38	18.04±2.19	<0.01*
<b>BMR</b> ( Kcal/d )	1435.51±255.84	1731.94±344.59	<0.01*
<b>Metabolic age ( years )</b>	20.42±3.95	22.14±6.24	<0.01**

\*Total examined-94, men -49, women-45; ONAP-optimal normal arterial pressure; HNAP-high normal arterial pressure.

BMI-body mass index; VFI-visceral fat index; FFMI-fat free mass index; BMR-basal metabolic rate; metabolic age.

**Table 2:** Hemodynamic indices in ONAP and HNAP groups:

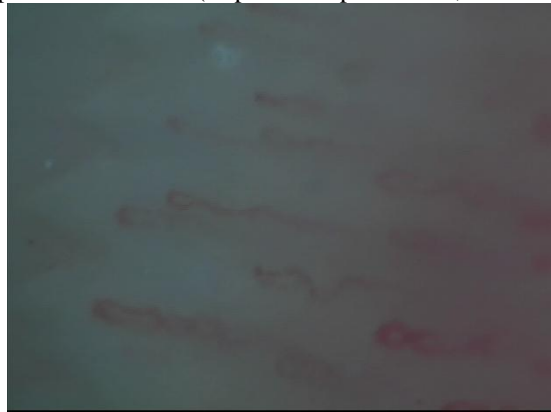
GROUPS INDICES	ONAP Mean ±SD N=35	HNAP Mean±SD N=33	P
<b>HR ( imp /min )</b>	86.79±13.27	86.07±12.82	>0.05
<b>TFC ( 1 /Ω )</b>	0.04±0.042	0.04±0.01	>0.05
<b>VI ( 1 /s )</b>	0.04±0.01	0.05±0.1	<0.05*
<b>SV ( ml / beat )</b>	75.61±24.03	84.49±28.43	>0.05
<b>SV / SI</b>	1.65±0.17	1.86±0.26	<0.05*
<b>CO ( l/min)</b>	6.36±1.76	7.22±2.11	>0.05
<b>CI (L/min )/m<sup>2</sup></b>	3.86±1.030	3.87±0.94	>0.05
<b>CO /CI</b>	1.65±0.17	1.86±0.26	<0.05*
<b>SVRI ( dynes.s.cm<sup>2</sup>.cm<sup>-5</sup>)</b>	1778.49±619.55	1929.37±635.24	>0.05
<b>LCWI ( gm.m/m<sup>2</sup>)</b>	6.08±1.78	6.70±1.96	>0.05
<b>STR</b>	0.44±0.07	0.46±0.11	>0.05
<b>MBP ( mm Hg )</b>	83.43±6.87	96.36±9.09	<0.05*
<b>Number of capillaries</b>	9.17±2.261	9.82±2.72	>0.05
<b>Abnormal capillaries, (%)</b>	12,50±11,68	16,36±16,64	>0.05
<b>Crossed capillaries (%)</b>	16.36 ±16.64	22.34±13.07	<0.05*
<b>a/v</b>	0,77±0,19	0,75±0,18	>0.05

Calculation of the stroke volume is according to the formula of Shramek-Bernstein [13].

\*Total examined- 68, men-30, women-38, ONAP-optimal, normal arterial pressure, HNAP-high normal arterial pressure

**HR-** Heart rate; **TFC-**Thoracic fluid content; **VI-** Velocity index; **SV -**Stroke volume; **CO-** Cardiac output; **CI-** Cardiac index; **SVRI-** Systemic vascular resistance index; **LCWI-**Left cardiac work index ; **STR-**Systolic time ratio; **MBP-** Mean blood pressure; **a/v-** mean arterial / venous capillary diameter.

**Fig.1:** Crossed capillaries in HNAP (Capillaroscope JH1005, PRC magnification  $\times 250$ .)



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