

The Fourth European Conference on Biology and Medical Sciences

13th January, 2015



«East West» Association for Advanced Studies and Higher Education
GmbH, Vienna, Austria

**Vienna
2015**

Proceedings of the 4th European Conference on Biology and Medical Sciences (January 13, 2015). «East West» Association for Advanced Studies and Higher Education GmbH. Vienna. 2014. 230 P.

ISBN-13 978-3-902986-23-8

ISBN-10 3-902986-23-9

The recommended citation for this publication is:

Mihai M. (Ed.) (2015). Proceedings of 4th European Conference on Biology and Medical Sciences (January 13, 2015). Vienna, OR: «East West» Association for Advanced Studies and Higher Education GmbH, Vienna.

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Typeset in Berling by Ziegler Buchdruckerei, Linz, Austria.

Printed by «East West» Association for Advanced Studies and Higher Education GmbH, Vienna, Austria on acid-free paper.

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The prognostic value of arterial hypertension and type 2 diabetes mellitus in cardiac remodeling and formation of arrhythmias

Arterial hypertension (AH) and diabetes mellitus (DM) represent the great medical, social, and economic problem worldwide. The combination of AH and DM increases their adverse effects on the cardiovascular (CV) system, heightens the risk of development of both macrovascular complications — stroke, myocardial infarction, sudden death, atherosclerotic peripheral vascular disease and microvascular lesions — retinopathy, nephropathy and neuropathy¹. The clinical course of AH and DM has several peculiarities, that are manifested by increased pulse pressure (PP) due to increased stiffness of arteries of medium and large diameter, which is a predictor of poor prognosis. It is proven, that the elevation of PP by 10 mm. Hg correlates with an increase of mortality by 20%².

An amendment of the geometrical model of the heart occurs in case of increased blood pressure (BP), as well as in the presence of DM. An enlargement of left ventricle (LV) is observed in patients with type 2 DM (T2DM), even in the absence of hypertension, due to hypertrophy of cardiomyocytes and the growth of interstitial component. In case of combined course of T2DM and hypertension, the addition of hemodynamic factor leads to remodeling of the left ventricle³.

In case of left ventricular hypertrophy (LVH) an increase of myocardial mass (MM) develops, which first appears as a compensatory response to raised blood

¹ Ruden I. Guidelines on diabetes, pre-diabetes, and cardiovascular disease: executive summary. The Task Force on Diabetes and Cardiovascular Diseases of the European Society of Cardiology (ESC) and of the European Association for the study of Diabetes (EASD)/Ruden I., Standl E., Barnic M., Betteridge I., Van den Bergh et al.//Eur.Heart.J. – 2012. – 28(1): 88–136.

² Blacher J. Pulse pressure not mean pressure determines cardiovascular risk on older hypertensive patients/Blacher J., Staessen J.A., Girerd X. et al.//Arch Intern Med. – 2006. – № 160. – P. 1085–1089.

³ Шляхто Е. В. Ремоделирование сердца при гипертонической болезни/Шляхто Е. В., Конради А. О.//Сердце. – 2012. – т. 1 – № 5(5). – С. 13–18.

pressure and helps to maintain the systolic function of the heart and to normalize the intramyocardial tension. In the future, compensatory LVH loses meaning and becomes an important independent risk factor for CV events, which increments in proportion to the degree of MM increases¹. AH creates the set of hemodynamic and non-hemodynamic factors that contribute to cardiac remodeling (CR), which, depending on the relative wall thickness (RWT) and MM index is classified into 4 types: normal heart model (NHM), eccentric left ventricular hypertrophy (ELVH), concentric left ventricular hypertrophy (CLVH) and concentric LV remodeling (CLVR). ELVH and CLVH belong to hypertrophic type of CR, while CLVR belongs to non-hypertrophic one accordingly².

The purpose of the study was to determine the influence of hypertension and type 2 diabetes on amendment of the geometric model of the heart and the development of arrhythmias.

Methods. A total of 64 patients were examined (mean age 58.6 ± 4.3 years, 35 women and 29 men) with hypertension of 2–3 degrees and type 2 diabetes in the stage of subcompensation. Mean duration of hypertension was 9.4 ± 2.8 years, mean duration of type 2 diabetes — 5.3 ± 1.7 years, mean body mass index (BMI) of patients — 26.2 ± 2.6 kg/m². The examination program included the assessment of carbohydrate metabolism (blood glucose fluctuations throughout the day by automatic analyzer Chem Well); glycosylated hemoglobin (HbA1c) by chromatography; echocardiography by Toshiba appliance — SSH — 60 A (Japan) according to standard procedures in the M and B modes; 24-hour Holter monitoring — cardiac monitoring system “RHYTHM” (Ukraine); ambulatory blood pressure monitoring (ABPM) by “MEDITECH” recorder (Hungary).

Statistical analysis was performed by the instrumentality of MS Excel v 7.0c using Student’s t-test, with the minimum accepted level of significance $p < 0.05$. The data obtained were compared with the results of a survey of 14 healthy volunteers, which formed the control group (7 men and 7 women, mean age — 47.5 ± 2.5 years).

Results. Patients were divided into 3 groups according to nosologic units, and were representative by gender and age: Group 1–22 hypertensive patients (11 of them women), Group 2–21 patients with T2DM (10 of them women), Group 3–21 patients with hypertension and T2DM (12 of them women).

Geometric model of the left ventricle was assessed by RWT and MM index. When MM index < data of the control group and RWT < 0.45 — evaluated as NHM; when

¹ Vakili B. A. Prognostic implications of left ventricular hypertrophy/Vakili B. A., Okin P. M., Devereux R. B.//Am.Heart.J. – 2009. – № 141. – P. 334–341.

² Джанашия П. X. Ремоделирование сердца и его роль в формировании аритмий у больных сахарным диабетом типа 2 и артериальной гипертензией/Джанашия П. X., Могутова П. A., Потешкина Н. Г., Аракелян М. С.//Рос. кардиол. ж. – 2008. – № 6. – С. 15–19.

MM index > data of the control group and RWT < 0.45 — as ELVH; when MM index > data of the control group and RWT > 0.45 — as CLVH; when MM index < control and RWT > 0.45 — as CLVR¹. LVH was diagnosed at MM rates greater than or equal to 125 g/m² for men and 110 g/m² for women².

The survey revealed changes of the geometric model of the heart, which were different in each group of patients. CLVH was found in the majority of patients in group 1 (51 %): MM index: 128.4 ± 10.6 g/m²; control group — 69.4 ± 5.2 g/m²; p < 0.05; RWT: 0.51 ± 0.04 conventional units (C. U.); control — 0.42 ± 0.03 C. U.; p < 0.05. ELVH was found in 22 % of patients, CLVR — in 16 % of patients, NM was detected only in 11 % of patients. CLVR predominated among patients of group 2 (58 %): MM index: 76.3 ± 4.2 g/m²; RWT: 0.49 ± 0.05 C. U.; p < 0.05. 15 % of patients had CLVH, 13 % — ELVH and 14 % — NM of the heart. As concerns group 3, majority of patients had CLVH (64 %): MM index 131.3 ± 4.8 g/m²; RWT 0.52 ± 0.05 C. U.; p < 0.05. Other types of remodeling were recorded less frequently in this group: CLVR (12 %), ELVH (17 %) and NM of the heart (7 %).

The analysis of ABPM parameters allowed us to determine the changes of circadian rhythm of blood pressure in all groups of patients: «dipper» type was found in groups 1, 2 and 3: 17 %, 39 % and 10 % respectively; «non-dipper» type — 56 %, 36 % and 58 % respectively; «night-peaker» type — 27 %, 25 % and 32 % of patients, respectively.

When comparing the data of ABPM and echocardiography it was noted that patients with inadequate nocturnal blood pressure reduction (non-dipper) and with nocturnal blood pressure increase (night-peaker) have enlarged LV cavity and increased MM index.

When analyzing the data of 24-hour Holter monitoring we found that patients with AH are significantly more likely to have cardiac abnormalities that were felt by patients (72 %), whereas 43 % of patients with T2DM showed no clinical signs of arrhythmias, which were detected only by additional research. Statistically significant ventricular arrhythmias were significantly more often (p < 0.05) observed in patients with AH: ventricular ectopic beats (VEB) and paroxysms of ventricular tachycardia (VT) (in the 1st, 2nd and 3rd groups VEB: 28 % 15 % and 37 % respectively; VT: 9 %, 4 % and 11 % respectively). At the same time, patients with T2DM significantly more often (p < 0.05) had supraventricular arrhythmias — atrial premature beats (APB) (in the 1st, 2nd and 3rd groups: 19 %, 84 % and 27 %, respectively) and paroxysmal atrial fibrillation (PAF) (in the 1st, 2nd and 3rd groups: 7 %, 31 % and 15 %, respectively). As concerns control group, only 2 people were observed to have isolated atrial extrasystoles during daylight hours.

¹ Джанашия П. Х. Ремоделирование сердца и его роль в формировании аритмий у больных сахарным диабетом типа 2 и артериальной гипертензией/Джанашия П. Х., Могутова П. А., Потешкина Н. Г., Аракелян М. С. // Рос. кардиол. ж. – 2008. – № 6. – С. 15–19.

² Schillaci G. Continuous relation between left ventricular mass and risk in essential hypertension/ Schillaci G., Verdecchia P., Porcellati C. // Hypertension. – 2009. – № 35. – P. 580–586.

A detailed analysis of ventricular arrhythmias was performed in examined patients, since ventricular arrhythmias are accompanied by more significant hemodynamic disorders and are predictors of sudden CV death. Particular attention was paid to the high-grade ventricular arrhythmias — paired VEB and paroxysms of VT of any duration. VEB were recorded very rarely in patients in the control group (only 2 patients — 14 %) and were represented by single monomorphic VEB no more than 6 per day, which were recorded in the afternoon hours (12.00 pm — 16.00 pm). At the same time, ventricular arrhythmias occurred much more frequently in patients with AH and T2DM. VEB were evaluated according to the classification of B. Lown, M. Wolf and M. Ryan¹. The high grade VEB were observed mainly in hypertrophic types of LV remodeling in examined patients (in the 1st, 2nd and 3rd groups: 3rd class by Lown's grade — 29 %, 28 % and 32 %, respectively; 4th class by Lown's grade — 30 %, 10 % and 21 %, respectively; 5th class by Lown's grade — 15 %, 1 % and 18 %, respectively).

Conclusions:

1. Hemodynamic and metabolic disorders that occur in patients with hypertension and type 2 diabetes, contribute to a change in the geometric model of the left ventricle.
2. Arterial hypertension influences the development of hypertrophic types of remodeling greater than isolated metabolic disorders do.
3. Ventricular arrhythmias predominate in patients with hypertrophic types of LV remodeling, whereas supraventricular arrhythmias are more often recorded in patients with non-hypertrophic types.
4. The combination of hypertension and type 2 diabetes leads to the formation and progression of CLVH, increases the risk of ventricular arrhythmias, as well as the occurrence of supraventricular arrhythmias, including paroxysmal atrial fibrillation.

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¹ Основы кардиологии: Принципы и практика (2-е издание)//Под ред. проф. Клива Розендорффа. – Львов: Медицина світу. – 2007. – 1064 с.

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Clinical case of developed intestinal fistula in patient with postoperational ventral hernia

Introduction. Treatment methods of patients with different types of intestinal fistula had developed in clinical surgery. Nevertheless, methods of operative