INTRODUCTION

Hypertension as an endemic disease

As one of the most frequent disease in developed countries worldwide hypertension is present in more than 20 % of the adult population in Hungary. We can call it endemic. Hypertension plays an important role in the pathogenesis of about 80% of the cardiovascular diseases it is also the most important risk factor of the myocardial infarct and the stroke. The risk factor grows higher whenever the degree of hypertension is higher or its existence is longer. The risk is higher even in those who have a normotension but in the upper normal level as a study, published in September of 2007.

Several factors play an important role in the developing of essential hypertension just as genetic factors (polygenic inheritance) and bad habits or way of living (surfeit, stress, overweigh, lack of sport, smoking, excessive consumption of salt, coffee, alcohol etc.), so we can call it a multifactorial disease. The resting blood pressure becomes higher because of several genetic disorders and of the life-style. Hypertension becomes more frequent with age: half of the population over 65 suffers from some type of hypertension.

Hypertension or hypertensive syndrome means not only that blood pressure is high but there are also other cardiovascular and metabolic differences, which we can call early alarming, adverse signs. Damage of target organs in hypertension can be noticed before elevated blood pressure that is why the concept of "normotensive hypertension" was introduced. The importance of the genetic factors in the development of hypertension is shown by the appearance of some adverse cardiac signs which can be associated with hypertension in the offspring of hypertensive parents, often without elevated pressure.

Echocardiographic variances are well defined in hypertension disease. Studies also describe the diagnostic criteria, morphological types, differentiation of left ventricular hypertrophy and failure of the systolic and diastolic function.

In my study I would not like to deal with secondary hypertension, rather I will discuss primer essential hypertension.

The role of regular exercise in the prevention, therapy, and rehabilitation of hypertension disease

Lack of exercise as a risk factor occurs in the development of hypertension, so regular physical activity is part of prevention among changing other bad habits of life-style. It is also an aid of therapy and rehabilitation before medication, naturally with appropriate medical control and skill. Regular training does not decrease the resting blood pressure as much as e.g. resting heart rate but studies from different authors claim the positive effect of regular training.

About the water polo

Water polo is a very special branch of sports, because it bears characteristics of both ball games and water sports. Thus, the complex character of the exercise in water polo makes finding valid methods of checking the fitness of players far from easy.

Of the team ball games, male water polo has the longest history in the Olympic Games; it was on the program in Paris even in 1900, and it has remained continuously on it until now. The Hungarian male water polo players are the number ones all around the world. Lately the women are competitors, too. Hungarian female water polo players, like the Hungarian males, are in the top ranks in the world. Within this short time Hungarian women have won two European, two World Championships and one World Cup first place. The author of the present dissertation was the goalkeeper of the Hungarian team that won the World Championship in Montreal in 2005.

AIMS, QUESTIONS

In my investigation, I tried to find answers for three questions.

1. What is the resting blood pressure like of the members in different sports compared to non-athletes? What are the values of the cardiac output and total peripheral resistance, determining the blood pressure, in the athletes? Which sports or what kind of training decreases the resting blood pressure, what kind of sports are recommended to prevent hypertension or to such persons who are disposed to hypertension?

2. Whether regular physical exercise would influence some of the adverse echocardiographic signs, mentioned in the introduction, which can be associated with hypertension in the offspring of hypertensive parents?

3. What kind of spiroergometric and echocardiographic data of female water polo players are found in comparison with other top-level female athletes and with healthy non-athlete females?

SUBJECTS AND METHODS

Subjects

1. Subjects in the comparison of the resting blood pressure

7-64-yr-old athlete and non-athlete males (N=1687, 172 athletes, 1515 non-athletes) and females (N=1687, 172 non-athletes, 1515 athletes) were observed. I closed up subjects in different branches but similar types of sports in order to achieve similar numbers within the groups.

2. Subjects in the investigations of the offspring of hypertensive and normotensive parents

215, 22-35-yr-old normotensive males (N=144) and females (N=71) were observed. Subjects that had one or both parents with hypertension and/or were on an antihypertensive treatment (positive family history: FH+) are called here offspring of hypertensive parents, while the subjects with normotensive parents were enrolled in the negative family history (FH–) group.

3. Investigations of the water polo players

Spiroergometric and echocardiographic data of elite female water polo players were compared with other top-level female athletes (ball-game-players, endurance athletes, sprinters, power athletes, artistic competitors) and with healthy non-athlete females. Ages were 18-35, respectively.

Echocardiographic investigations

Echocardiographic investigations were made by a Dornier AI 4800 type device by a 2.5 MHz transducer, always at rest in the morning hours. Interventricular septum thickness (IVSTd), left ventricular (LV) posterior wall thickness (LVPWTd) and the internal diameter (LVID) were detected in 2D-guided M-mode parasternal depictions. End-diastolic LV wall thickness (LVWT) and muscle mass were calculated: LVWT=IVSTd+LVPWTd and $LVMM=(TEDD^3-LVIDd^3)\cdot 1.053$, where TEDD is the total LV diameter (LVWT+LVID) and 1.053 is the specific gravity of the cardiac muscle. Muscular quotient (MQ) is the ratio LVWT/LVID. LV filling was determined by the ratio of the peak velocity measured during the early and late phase (E/A), the deceleration time of the early diastolic filling period (EDT) and the isovolumetric relaxation time (IVRT). Stroke volume (SV) was calculated as the difference of end-diastolic and end-systolic volumes, SV multiplied by the heart rate gave the cardiac output (CO). Total peripheral resistance was calculated using the resting blood pressure values and the CO. Cardiac measures were referred to the body surface area by fractions in which the exponents of the numerator and denominator are identical.

Blood pressure measurement

The measurements were made by certified sphygmomanometer in all investigations. The mean arterial blood pressure was calculated according to the known formula: MAP=BPDIAST+(BPSYST-BPDIAST)/3 , where MAP the mean arterial blood pressure, BPSYST the systolic blood pressure and BPDIAST the diastolic blood pressure.

Peak oxygen consumption

Relative aerobic power (VO_2max) was determined by measuring peak oxygen uptake by online computer-assisted open-circuit spirometry (Jaeger Dataspir Analyzer, Firma Jaeger, Aachen, Germany) during a multistage incremental treadmill exercise (Jaeger 6000 EL, Firma Jaeger, Aachen, Germany). Strain type during spiroergometric examinations was "vita maxima". In the spiroergometric data only the relative, body mass related maximal oxygen uptake (rel. VO_2max, $ml\cdot kg^{-1}\cdot min^{-1}$) was used.

Statistical analysis (Statistic for Windows 6.0)

Differences were tested at the $p<0.05$ level.

1. Investigations of the resting blood pressure

While the mean arterial blood pressure of men and women differs statistically by *t*-test for independent samples, men and women were observed separately. One-way ANOVA analysis was performed to compare the mean arterial blood pressure values of the different groups. In case of group differences, post hoc Tukey-test was used to establish, between which groups were significant differences. *T*-test for independent samples was performed to compare the relative TRP and CO values of the athletes with the non-athlete ones.

2. Comparison of the FH– and FH+ groups

Group comparisons were made by two-variables ANOVA (physical activity status and family history status) with post-hoc Tukey analysis in both genders.

3. Water polo and ball game players

One-way ANOVA (independent samples) analysis was performed to compare mean values of the groups. In case of group differences, post hoc Tukey-test was used to establish, between which groups were significant differences.

RESULTS

1. The resting blood pressure and its determining factors

There was a difference between male power athletes depending on whether the sport is a dynamic or static type. The mean arterial blood pressure of static power athletes (such as weight-lifters and body builders) was higher compared to the controls, while that of the dynamic type (judo, karate, box) was lower. The values obtained from throwers did not differ from the non-athletes. The mean arterial blood pressure of the endurance athletes was around the values of the controls that of cyclists and pentathalonists were a bit higher. Water polo and other ball game players' data were different: water polo players provided higher values. Other ball game players (soccer, basketball, tennis) had lower values than the control. The mean arterial blood pressure of sprinter athletes and artistic sportsmen was lower than the non-athletes.

The tendency at women is similar as well as of men: the mean arterial blood pressure values of static and dynamic power athletes were differing, static power athletes have higher blood pressure than the dynamic ones. Throwers' data is similar to the non-athletes, too. Out of endurance athletes, the cyclists' and pentathalonists' results were a bit higher but it wasn't significant compared to the control group. Out of endurance sports, in kayak-canoe, rowing, and swimming, synchronized swimming the values were significantly lower compared to the non-athletes. The water polo players provided higher values than handball, basketball, volleyball and tennis players. The values of tennis players were significantly lower than the non-athletes. The values of sprinter athletes were similar to non-athletes, while that of the artistic sportswomen were significantly lower.

Although there were no significant differences in the values of the relative TPR and CO of the athletes compared to non-athletes, the athletes had a bit lower relative CO and higher relative TPR. According to my results in case of different types of sports (such as ball games, dynamic power sports, sprinter athletes, artistic sports), the resting blood pressure was lower compared to the non-athletes, although the relative TPR did not decrease. In these types of sports the decreasing of the CO would effect the decreasing of the resting blood pressure. At weight-lifters and body builders, where the resting blood pressure was higher compared to the non-athletes, the TPR was higher and the CO lower. In this group the increasing of the TPR would effect the increasing of the resting blood pressure.

2. Data of athletic and non-athletic offspring of normotensive and hypertensive parents

Non-athlete male and female FH+ subjects did not show higher relative LV sizes in comparison with the FH– ones. In the athlete groups substantively higher relative LVWT, relative LVMM and MQ were found in comparison with the non-athletes, no difference was detected between the FH+ and FH– athlete groups. In the non-athlete male and female FH– and FH+ groups resting HR means did not differ statistically. The E/A quotient was, however, significantly lower in the FH+ groups in both genders in comparison with the non-athlete FH– ones. IVRT and relative IVRT were slightly but not significantly longer in the non-athlete male FH+ groups in comparison with non-athlete male FH– ones, these results means an impairment of the diastolic function. Resting HR was markedly lower in all of the athlete groups than in the respective non-athlete ones. The E/A quotient of the athlete FH– groups did not differ from the quotient of the non-athlete FH– subjects, but it was higher in the FH+ athletes than in the non-athlete FH+ ones. The difference was significant in the males. As a consequence, in the athletes no differences were seen in any parameters between FH– and FH+ groups.

3. Echocardiographic and spiroergometric data of water polo players

Resting HR was the slowest in the water polo players and endurance athletes, and significantly slower than in non-athletes. The highest mean for relative aerobic capacity was seen in the endurance athletes, whose VO_2max was significantly higher than that of the water polo players whose values were not significantly different from those of the other five groups. The means of relative left ventricular wall thickness (relative LVWT) and left ventricular muscle mass (relative LVMM) of the water polo players, endurance competitors and power athletes were larger than that of the controls. The athletes appeared to have slightly higher mean E/A quotients, but the overall F-test of ANOVA did not show any significant difference among the examined groups.

CONCLUSIONS

1. The regular physical activity decreases the resting blood pressure, the degree depending on the type of the sport. The decreasing cardiac output is the reason of the decreasing resting blood pressure. According to my results the dynamic exercises are recommended to the prevention of hypertension.

2. Some adverse, early cardiovascular signs of hypertension can be found in the normotensive offspring of hypertensive parents. In my present data the diastolic function showed some modifications in the non-athlete offspring of hypertensive parents. Regular physical exercise seems to protect the offspring from the adverse cardiac signs which can be associated with hypertension when one has hypertensive parents. Regular physical exercise is

recommended to precede hypertension, but it is expressly recommended, moreover obligatory to the offspring of hypertensive parents.

3. The echocardiac features of top-level female water polo players were, as well as the male water polo players similar to the elite endurance female athletes. Their mean relative aerobic power, measured in an all-out treadmill run, was worse than that of other top-level athletes, like the male water polo players. This observation corroborated the validity of the assumption that swimming tests were more suitable to check the physical fitness and condition of water polo players.

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