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HYPERTENSION IN ATHLETES

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Introduction

Blood pressure increases with age. Systolic blood pressure continues to increase throughout adult life, related to progressive arterial stiffening, whereas diastolic blood pressure plateaus in the sixth decade of life and decreases thereafter. The prevalence of hypertension in the population amounts to ~ 25%. When broken down by age and gender, the prevalence is approximately 15%, 30%, and 55% in men aged 18–39 yrs, 40–59 yrs, and ≥ 60 yrs, respectively, and about 5%, 30%, and 65% in women in these age groups. These epidemiological data indicate that hypertension may already be present in the young athlete, though rarely, but will occur more frequently in the older sportsman. However, ~ 25% of patients with hypertension by conventional measurements have a normal blood pressure on 24-hour ambulatory monitoring or on home blood pressure measurements, so-called white-coat hypertension [1], and it has been shown that young athletes with clinic hypertension often have normal blood pressure on ambulatory monitoring [2].

Approximately 95% of patients with hypertension have essential or primary hypertension which results from an interaction between genetic factors and lifestyle/environmental factors including being overweight, high salt intake, excessive alcohol consumption, and physical inactivity. However, the role of blood pressure increasing ergogenic aids should be considered in the hypertensive sportsman or athlete. Athletes may be taking large doses of prohibited substances such as anabolic steroids, erythropoietin, stimulants, and so forth. The uncontrolled use of these agents has been associated with numerous side effects including hypertension. In addition, the use of non-steroidal, anti-inflammatory drugs should be specifically considered, since these compounds may increase blood pressure and are commonly used in the athletic setting.

Assessment of the severity of hypertension and risk stratification

The severity of hypertension does not only depend on the blood pressure level but also on the presence of other cardiovascular risk factors, target organ damage, and cardiovascular and renal complications, so patients are accordingly classified as having low, moderate, high, or very high added risk in comparison with healthy normotensives without risk factors [3]. With regard to left ventricular hypertrophy, it should be noted that sports activity itself may induce hypertrophy; the type of hypertrophy and assessment of diastolic left ventricular function may help to distinguish between hypertensive heart disease and athlete's heart [4–8]. Athlete's heart typically shows maintained diastolic function, and is, in general, considered a physiological adaptation to training, in contrast to the hypertrophy secondary to hypertension. Hypertensive patients usually have concentric left ventricular hypertrophy, but eccentric hypertrophy has also been described [9]. Whether or not hypertension in an athlete will trigger or accentuate the cardiac hypertrophy, or athletic exercise in a person with hypertrophy secondary to hypertension will worsen the hypertrophy, is not known.

Assessment of the risk associated with exercise

Exercise-related sudden death at a younger age is mainly attributed to hypertrophic cardiomyopathy, anomalies of the coronary arteries, or arrhythmogenic right ventricular dysplasia [8, 10–12] and is unlikely to be related to hypertension. On the other hand, coronary heart disease has been identified in approximately 75% of victims of exercise-related sudden death above the age of 35 years. Whether high blood pressure is a cause of exercise-related sudden death on its own is not known, but hypertension is certainly a major risk factor for the development of coronary artery disease. In addition, hypertension-induced left ventricular hypertrophy may cause life-threatening ventricular arrhythmias [13]. It is likely that the risk associated with exercise can be derived from the overall risk stratification. Therefore, the general approach to the hypertensive patient should also apply to the exercising patient.

Diagnostic evaluation

Diagnostic procedures are aimed at 1) establishing blood pressure levels; 2) identifying secondary causes of hypertension; 3) evaluating the overall cardiovascular risk by searching for other risk factors, target organ damage and concomitant diseases or accompanying clinical conditions [3]. Diagnostic procedures comprise a thorough individual and family history, physical examination including repeated blood pressure measurements according to established recommendations, and laboratory and instrumental investigations, of which some should be considered part of the routine approach in all subjects with high blood pressure, some are recommended, and some are indicated only when suggested by the core examinations. In addition, echocardiography and exercise testing with ECG and blood pressure monitoring are indicated as routine tests in the competitive athlete with hypertension [14, 15]. In the common hypertensive sportsman, the indication for exercise testing depends on the patient's risk and on the amateur/leisure-time sports characteristics [15, 16] (Table 1). In patients with hypertension about to engage in hard or very hard exercise (intensity ≥ 60% of maximum), a medically supervised peak or symptom-limited exercise test with ECG and blood pressure monitoring is warranted. In asymptomatic men or women with low or moderate added risk, who engage in low-to-moderate physical activity (intensity < 60% of maximum), there is generally no need for further testing beyond the routine evaluation. Asymptomatic individual patients with high or very high added risk may benefit from exercise testing before engaging in moderate-intensity exercise (40–60% of maximum) but not for light or very light activity (< 40% of maximum). Patients with exertional dyspnoea, chest discomfort, or palpitations need further examination, which includes exercise testing, echocardiography, Holter monitoring, or combinations thereof.

Table 1. Indications for exercise testing for sports participation in patients with hypertension

Demands of exercise Static and/or dynamic	Risk category	
	Low or moderate	High or very high[§]
Light (< 40% of max)	No	No
Moderate (40–59% of max)	No	Yes
High (≥ 60% of max)	Yes	Yes

[§]In case of an associated clinical condition, the recommendations for the specific condition should be observed

A major problem with exercise testing in a population with a low probability of coronary heart disease and in subjects with left ventricular hypertrophy is that the majority of positive tests on electrocardiography are falsely positive. Stress myocardial scintigraphy or echocardiography, and ultimately coronarography, may be indicated in cases of doubt. There is currently insufficient evidence that the blood pressure response to exercise should play a role in the recommendations for exercise in addition to blood pressure at rest [17]. However, subjects with an excessive rise of blood pressure during exercise are more prone to develop hypertension and should be followed-up more closely [15]. Finally, physicians should be aware that high blood pressure might impair exercise tolerance [18].

Effects of exercise on blood pressure

Dynamic exercise

Blood pressure increases during acute dynamic exercise in proportion to the intensity of the effort [18, 19]. During longer-term stable exercise, the blood pressure tends to decrease after an initial increase of short duration. The increase is greater for systolic than for diastolic blood pressure which only slightly increases or even remains unchanged. For the same oxygen consumption, the rise is more pronounced in older subjects and when exercise is performed with smaller rather than with larger muscle groups. Acute exercise is usually followed by post-exercise hypotension which may last for several hours and is generally more pronounced and of longer duration in patients with hypertension than in normotensive subjects [16, 19].

Cross-sectional and longitudinal epidemiological studies indicate that physical inactivity and low fitness levels are associated with a) higher blood pressure levels and b) increased incidence of hypertension in the population [20]. Meta-analyses of randomized controlled intervention studies concluded that regular dynamic endurance training at moderate intensity significantly reduces blood pressure [21–23]. A recent meta-analysis involved 72 trials and 105 study groups [23]. After weighting for the number of participants, training induced significant net reductions of resting and daytime ambulatory blood pressure of, respectively, 3.0/2.4 mm Hg ($P < 0.001$) and 3.3/3.5 mm Hg ($P < 0.01$) were calculated. The reduction of resting blood pressure was more pronounced in the 30 hypertensive study groups (–6.9/–4.9) than in the others (–1.9/–1.6) ($P < 0.001$ for all). There was no convincing evidence that the blood pressure response depended on training intensity between ~40% and ~ 80% of maximal aerobic power [21, 23].

Static exercise

Blood pressure increases during acute static exercise, and the increase is more pronounced than with dynamic exercise, particularly with heavy static exercise at an intensity of > 40–50% of maximal voluntary contraction. In a recent meta-analysis of randomized controlled trials, 'resistance' training at moderate intensi-

Table 2. Recommendation for strenuous leisure time physical activity and competitive sports participation in athletes with systemic hypertension according to the cardiovascular risk profile

Risk category	Evaluation	Criteria for eligibility	Recommendations	Follow-up
Low added risk	History, PE, ECG, ET, echo	Well controlled BP	All sports	Yearly
Moderate added risk	History, PE, ECG, ET, echo	Well controlled BP and risk factors	All sports, with exclusion of high static, high dynamic sports (III C)	Yearly
High added risk	History, PE, ECG, ET, echo	Well controlled BP and risk factors	All sports, with exclusion of high static sports (III A–C)	Yearly
Very high added risk	History, PE, ECG, ET, echo	Well controlled BP and risk factors; no associated clinical conditions	Only low-moderate dynamic, low static sports (I A–B)	6 months

BP — blood pressure; PE — physical examination, including repeated blood pressure measurements according to guidelines; ECG — 12-lead electrocardiography; ET — exercise testing; echo — echocardiography at rest

ty was found to decrease blood pressure by 3.5/3.2 mm Hg [24]. The meta-analysis included nine studies designed to increase muscular strength, power, and/or endurance, and all but one study involved dynamic rather than purely static exercise. In fact, few sports are characterized by purely static effort. However, only three trials in the meta-analysis reported on patients with hypertension.

Recommendations

General recommendations

Athletes with hypertension should be treated according to the general guidelines for the management of hypertension [3, 15, 25]. Appropriate non-pharmacological measures should be considered in all patients. Antihypertensive drug therapy should be started promptly in patients at high or very high added risk for cardiovascular complications. In patients at moderate added risk, drug treatment is only initiated when hypertension would persist for several weeks despite appropriate lifestyle changes. In patients at low added risk drug treatment may be delayed for several months; however, even in these patients lack of blood pressure control after a suitable period should lead to initiation of drug treatment. The goal of antihypertensive therapy is to reduce blood pressure to at least below 140/90 mm Hg and to lower values if tolerated in all hypertensive patients, and to below 130/80 mm Hg in diabetics and other high or very high risk conditions. Current evidence indicates that patients with white-coat hypertension do not have to be treated with antihypertensive drugs, unless they are at high or very high risk, but regular follow-up and non-pharmacological measures are recommended [3]. In addition, subjects with normal blood pressure at rest and exaggerated blood pressure response to exercise should be followed-up more closely.

Choice of drugs

Several drug classes can be considered for the initiation of antihypertensive therapy: diuretics, beta-blockers, calcium channel blockers, angiotensin converting enzyme inhibitors, and angiotensin II receptor blockers [3]. However, diuretics and beta-blockers are not recommended for first-line treatment in patients engaged in competitive or high-intensity endurance exercise [15, 18, 25]. Diuretics impair exercise performance and capacity in the first weeks of treatment through a reduction in plasma volume, but exercise tolerance appears to be restored during longer-term treatment; nevertheless, diuretics may cause electrolyte and fluid disturbances, which are not desirable in the endurance athlete. Beta-blockers reduce maximal aerobic power by, on average, 7% because of the reduction in maximal heart rate, which is not fully compensated by increases in maximal stroke volume, peripheral oxygen extraction, or both. Furthermore, the time that submaximal exercise can be sustained is reduced by ~ 20% by cardioselective beta-blockers and by ~ 40% by non-selective beta-blockers, most likely as a result of impaired lypolysis [18, 26, 27]. In addition, diuretics and beta-blockers are on the doping list for some sports, in which weight loss or control of tremor is of paramount importance. Diuretics are also banned because they may be used to conceal the use of other doping agents, such as anabolic steroids, by diluting the urine samples. The hypertensive athlete who has to use a diuretic and/or a beta-blocker for therapeutic purposes should follow the 'International Standard for Therapeutic Use Exceptions' of the World Anti-Doping Agency (WADA).

Calcium channel blockers and blockers of the renin–angiotensin system are currently the drugs of choice for the hypertensive endurance athlete [18, 28] and may be combined in case of insufficient blood pressure control. However, the combination of an angiotensin converting enzyme inhibitor and an angiotensin II receptor blocker is currently not advocated for the treatment of hypertension. If a third drug is required, a low dose thiazide-like diuretic, possibly in combination with a potassium-sparing agent, is recommended. There is no unequivocal evidence that antihypertensive agents would impair performance in 'resistance' sports.

Recommendations for sports participation

Recommendations for the participation of athletes with hypertension in competitive sports are based on the results of evaluation and on risk stratification, and with the understanding that the general recommendations for the management of hypertension are observed, as described above, and provided that the clinical condition is stable. Table 2 summarizes the recommendations with regard to competitive sports participation [14, 15]. The same recommendations may apply to patients who aim to engage in hard or very hard leisure-time sports activities in order to substantially enhance performance. However, most recreational physical activities are performed at low-to-moderate intensity. Dynamic sports activities are to be preferred, but also low-to-moderate resistance training is not harmful and may even contribute to blood pressure control [24]. In cases of cardiovascular or renal complications, the recommendations are based on the associated clinical conditions.

Finally, all patients should be followed-up at regular intervals, depending on the severity of hypertension and the category of risk. In addition, all exercising patients should be advised on exercise-related warning symptoms, such as chest pain or discomfort, abnormal dyspnoea, dizziness, or malaise, which would necessitate consulting a qualified physician.

Summary

Hypertension is rare in the young but its prevalence increases with aging. The overall risk of the hypertension patient does not only depend on blood pressure but also on the presence of other cardiovascular risk factors, target organ damage, and associated clinical conditions. The recommendations for pre-participation screening, sports participation, and follow-up depend on the cardiovascular risk profile of the individual athlete. When antihypertensive treatment is required, calcium channel blockers and blockers of the renin-angiotensin system are currently the drugs of choice.

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