



E-LEARNING IN SPORTS MEDICINE

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Electronic lecture presentations in sports medicine education have been used in our faculty for many years. However their electronic presentation via Mefanet was not available to students of our faculty until 2009. They are running during 2010-2011 and are under review at the present time. Subsequently they will be available for all medical faculties throughout the Czech Republic.

The following titles are currently available:

- Post-exercise broncho constriction,
- Physical activity in prevention of diseases,
- Metabolic syndrome and physical activity,
- Hypertension and physical activity,
- Spiroergometrie in cardiac and pulmonal diseases,
- Traumatic and overuse injuries of the musculoskeletal system,
- Doping and doping control,
- Sport and age,
- Morbus Scheuermann,
- Adaptation of human body to physical activity in sportsmen.

In this article we present the exercise test (stress test) in patients with coronary heart diseases (CHD), or suspicious CHD.

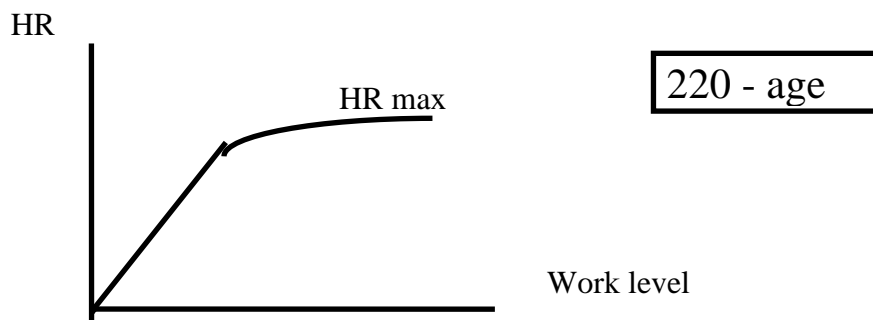
Key words: e-learning, sports medicine, coronary heart disease, exercise testing

Exercise (stress) testing in sports medicine

Heart rate (HR)

The most characteristic response to exercise is an increase in the sinus rate. At any given increase in work load, the heart rate accelerates, coming to a steady rate after three or four minutes. Patients with cardiac insufficiency may take longer to reach a steady rate.

Maximal heart rate (= 220 - age)





Note: HR max is not the criterion for the difference between well-trained and untrained people. HR max is approximately the same both in trained and in untrained men. However at the same HR max the well trained man performs the load of the higher intensity.

Adaptive changes through endurance training

Bradycardia:

The resting pulse is characteristically slower in trained than sedentary individuals 40/min and even slower. The resting HR in highly conditioned endurance-trained athletes could even be 28-40/min. This is mediated through the vagus nerve complex (prominent vagus arrhythmia). With an increased work load the HR of physically conditioned people tends to remain below that of the unconditioned control at each level.

Stroke volume (SV)

In the well conditioned individual, SV tends to increase throughout an increasing work load. In the sedentary people SV remains the same both in rest and in work

Athletes' heart

Cardiac output (C.O.): $SV \cdot HR = C.O.$

The conditioned individual: $200 \cdot 200 = 40 \text{ l / min.}$

The sedentary person: $90 \cdot 200 = 18 \text{ l / min}$

Blood pressure (BP) in rest

There are no significant differences in BP between athletes and non athletes Even also hypertensive men, after physical conditioning, it demonstrated that the resting blood pressure lowered, principally diastolic.

Isometric exercise (IE)

IE develops muscular strength and hypertrophy. Such conditioning however has no significant influence upon the performance of endurance activity. There are no changes in the resting HR and no changes in peak oxygen consumption. For the patients with coronary heart disease, it may present a definite risk.

Exercise training and coronary heart disease

Target: to improve aerobic metabolism without increasing significant oxygen debt

Method: aerobic endurance interval training (with rest periods).

Results: Bradycardia means longer diastolic coronary artery flow time. The time to onset of angina pectoris in standardized effort is prolonged. On the ground of the decrease the content and uptake of catecholamines in the myocardium the lessening of tendency toward ectopic rhythm was observing.

Exercise should be strictly individual!

After exercise testing (BE or treadmill) the physician must assess:

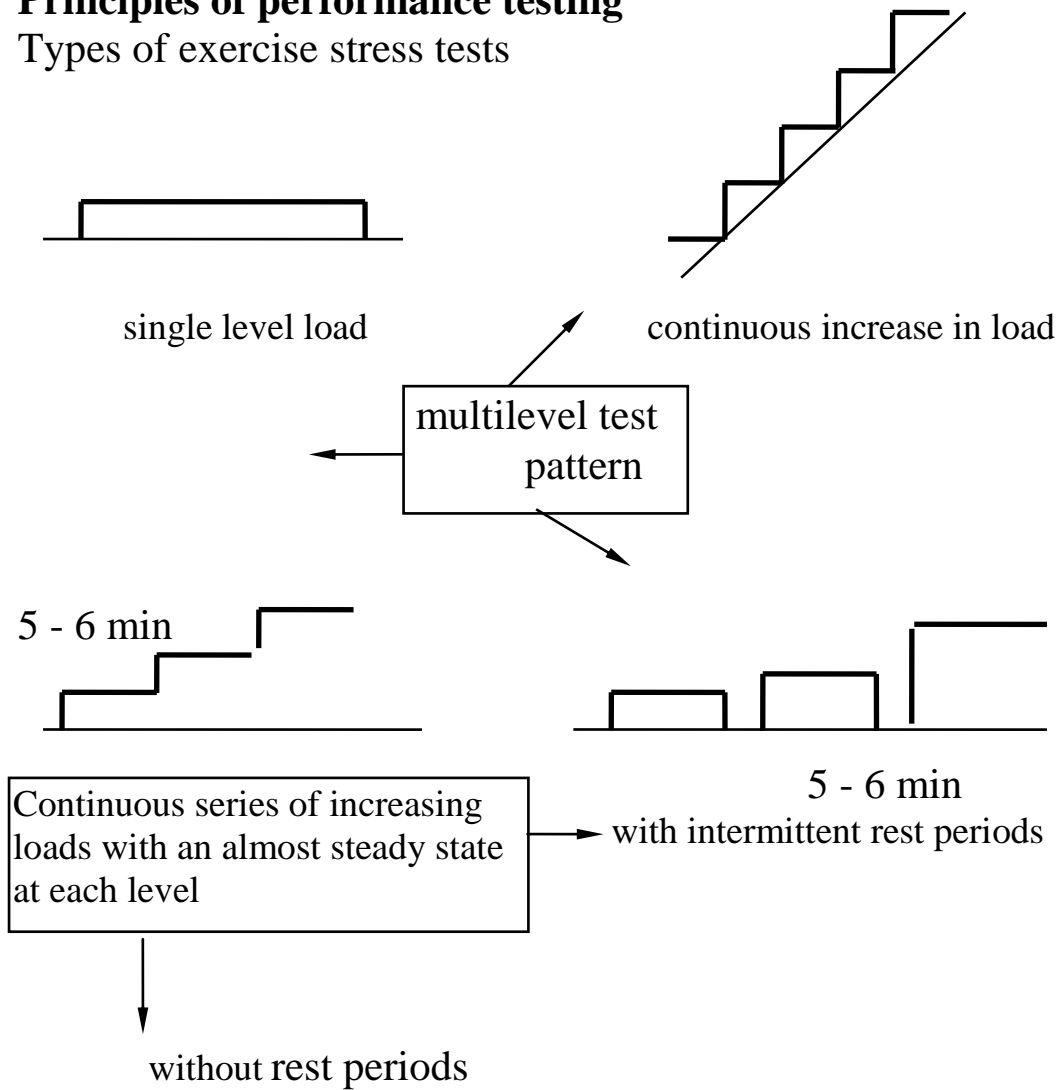
Maximal symptom - limited (s.l.) work capacity (HR max s.l.)

HR for training = (HR max s.l. - HR rest). 60 % + HR rest



Principles of performance testing

Types of exercise stress tests



Test may be carried out on:

- bicycle ergometer : supine bicycling
erect bicycling
- cranking ergometer
- treadmill
- steps : Master two - step test
other step tests

The necessary measurements:

- HR from the ECG
- BP by cuff
- ECG monitoring continuously
- VO₂,



Why use stress tests?

- To establish, from ECG observations, a diagnosis of overt heart disease and also to screen for possible silent coronary disease in seemingly healthy men and women. Approximately 30 % of the people with confirmed coronary artery disease have normal resting electrocardiograms. During relatively intense exercise, however, about 80 % of these abnormalities are uncovered.
- To reproduce and assess exercise-related chest symptoms. In many instances, individuals over the age of 40 suffer chest or related pain in the left shoulder or arm on physical exertion. Proper electrocardiographic analysis during an exercise stress test helps identify myocardial abnormalities and provides a more precise diagnosis of exercise-induced pain.
- To screen candidates for preventive and cardiac rehabilitative exercise programs: intensity, frequency, duration, and type of exercise.
- To detect an abnormal blood pressure response. It is not uncommon to find individuals with a normal resting blood pressure who show higher than normal increases in systolic blood pressure with exercise. This exercise hypertension may signify developing cardiovascular complications.
- To monitor responses to various therapeutic interventions (drug, surgical, and dietary) designed to improve cardiovascular functioning
- To monitor the success of coronary by-pass surgery.
- To define the functional aerobic capacity and evaluate its degree of deviation from normal standards.

Stress test contraindication

Absolute:

- Myocardial insufficiency
- Impending myocardial infarction
- Acute myocardial infarction
- Stenocardia in rest
- Significant congenital or rheumatic heart disease especially severe aortic stenosis
- Aortic or ventricular aneurysm.
- Embolia pulmonalis acute
- Severe arrhythmia at rest: multifocal EB, R/T phenomenon
 - bigeminy, trigeminy
 - second or third degree of the heart block
 - active myocarditis
 - uncontrolled hypertension > 230/120
 - thrombophlebitis
 - acute infectious diseases



Relative:

- Severe kidney diseases
- Active liver diseases
- Active central nervous system diseases
- marked diabetes
- Patients with fixed rate pacemakers
- Atrial fibrillation

Selecting the proper type of stress test

We prefer the multi-stage test with intermittent rest periods

25, 50, 75 W in patients early after myocardial infarction

0.5 1.0 1.5 W per kg or

1.5 2.0 2.5W per kg in other cases

Note: A resting electrocardiogram should precede the exercise test.

BE - Advantages:

- Accurate dosing of work level
- Reproducibility
- The recording of high quality ECG tracing

Disadvantages:

- Not everyone can pedal the bicycle
- Quadriceps fatigue

With electronically braked ergometers power output remains fixed within a range for a specified rate of pedaling. With mechanically loaded ergometers, power output is directly related to rate of pedaling. Pedaling rate for mechanically braked ergometers is usually set at 50 or 60 revolutions per min.

Treadmill

Advantage:

- No special skill is needed to walk

Disadvantages:

- Treadmill is large, costly, and noisy.
- ECG tracing tends to have more artifacts

To improve the quality of the ECG tracing, the mill can be stopped for a few seconds at the end of each work load.

- the work load is determined by the speed of the belt and the gradient (inclination)

ECG lead placement

The precordial electrodes V_{1-6} we put similar as the in the rest.

The electrodes R, L we displace on the right and left clavícula

N, F we displace on the right and left crista ilica

We stick electrodes with a special tape, or they are adhesive (sticky), or they are connected with a vacuum pump system.

For exercise testing we need:

- defibrillator
- the bed with the hard surface



- the emergency plan
- medicaments for resuscitation
- oxygen (in bottle, or central distributing)
- suck off instrument (sucking pump)
- breathe - instrument (AMBU bag)
- the possibility of the patient transfer to the coronary care unit - immediately after an accident

Guidelines for stress testing - test endpoints

The following guidelines should be used for stopping a stress test.

- objective evidence of exhaustion
- severe ischemic symptoms:
 - chest pain
 - dyspnoea
 - ECG changes: ectopic beats (EB), especially ventricular EB, bigeminy, trigeminy
 - multifocal EB, R on T phenomenon
 - ST depression: horizontal > 0.2 mV
 - descendent

-BP > 230/120

Patient may be very seldom “**walked through**” his angina. Possibly later opened collaterals are present and permit the individual to walk through his pain.

Blood pressure

During a graded exercise test, there is a normal, progressive increase in systolic blood pressure from about 120 torr to 160 to 190 torr at peak exercise. The change in diastolic pressure is generally less than 10 torr. For some individuals, strenuous exercise may cause the systolic blood pressure to rise well above 200 torr, whereas the diastolic pressure can increase to 100 to 150 torr. That means hypertensive response.

Systolic pressures of 240 to 250 mmHg have been reported in normal, healthy, highly trained athletes at maximal levels of exercise.

The inability of blood pressure to increase with exercise can also reflect cardiovascular malfunction.

Exercise-induced indicators of coronary heart disease (CHD)

• Angina Pectoris

Approximately 30 % of the initial manifestations of CHD take the form of chest-related pain called angina pectoris. This is temporary but painful condition that indicates that coronary blood flow (oxygen supply) has momentarily reached a critically low level. (Usually the result of restricted coronary circulation brought about by coronary atherosclerosis.) The resulting pain is generally felt in the upper chest region in the left shoulder, neck, or left arm. The depressed myocardial function is accompanied by reduced cardiac output, through reduced stroke volume.

Electrocardiographic Disorders

Those individuals with significant horizontal S-T-segment depression usually have severe and extensive obstruction of the coronary arteries. This generally involves a reduction of more than 70 % of the normal opening of one or more coronary vessels. The ST segment is



considered the most valuable electrocardiographic parameter for establishing the diagnosis of ischemic heart disease. The J point is a critical feature in these evaluations-junction of the QRS complex and the ST segment. Exercise frequently produces a lowering of the J point level, and sometimes this may be several millimeters. This response in itself is considered within normal limits. It may be produced by repolarization effects of the atria or by earlier ventricular repolarization secondary to the faster heart rate.

The ST segment may be either horizontal or downward sloping from the J point. If the segment then becomes 2 mm or more below the isoelectric line and horizontal, this finding is of course considered a significant sign of ischemia. However, the development of **ST segment elevation** during exercise has the same significance as ST segment depression. Such ST segment elevation changes may occur in the presence of **ventricular aneurysm** or **severe myocardial ischemia**.

Alterations in the T wave produced by exercise have much less specificity than ST segment changes. Food, digitalis, potassium deficiency, drinking cold water, emotional excitement may induce T wave changes. T wave inversion during the immediate post-exercise recovery is considered an innocuous finding.

Several artifactual causes of ST segment displacement must be considered in interpretation: drugs (e.g. digitalis).

A borderline exercise stress test: Some cardiac cycles have J point depression only, while others have significant horizontal depression of the ST segments.

The negative exercise electrocardiogram does not guarantee the absence of either myocardial ischemia or coronary heart disease. Ischemia is unlikely, however, if the test has been carried out to at least 85 % predicted maximal heart rates without symptoms and adequate recording of more than one lead.

Cardiac Rhythm Abnormalities

Premature ventricular contractions “extra-ventricular beats” (Ectopic beats- EB) in exercise generally mean the presence of severe ischemic atherosclerotic heart disease, often involving two or more major coronary vessels.

Ventricular Arrhythmias

Ventricular premature contractions (EB)

EB can be classified into two groups according to seriousness.

- **Physiological EB:** unifocal, infrequent

Physiological EB often disappear during exercise. Pharmacologic block of vagal tone with atropine to accelerate the heart rate may eliminate EB even without exercise.

- **Pathological EB**

EB are considered hazardous when they are multifocal. Ventricular couplets, triplets, or runs of ventricular tachycardia mean signs of serious risk.

Any of the above appearing during exercise stress testing is a cause for discontinuation of the procedure.

Some authorities consider the appearance of EB during exercise in the individual who is free of these at rest, or an increase in frequency in those having EB at rest, as pathologic and dangerous.

Impulse conduction

Significant conduction defects appearing during stress testing, such as A-V block or bundle branch block, may be caused not only by ischemic heart disease but also by cardiomyopathy.



Therefore, one cannot conclude that coronary atherosclerosis is present when these forms of conduction defects appear on the exercise electrocardiogram.

Non - standard exercise stress tests:

- Holter - monitoring = long time ECG monitoring
- Radio telemetry monitoring during different activity: walking, dancing, tennis skiing, running and monitoring sexual activity.

Recovery period after the stress test:

ECG recording still 10 min. at least in horizontal position is necessary. Then the patient sits down. He/she must stand up slowly and is to sit for 1 hour in the waiting room. No shower and no sauna are recommended immediately after the stress test.

The prescription of exercise

Each patient must be taught to count his own pulse rate!

We estimate him:

- HR max means the upper limit of his/her HR
- HR for training means optimal HR for exercise

We recommend HR measurement immediately after physical activity during the first 6 or 10 s.

The training pattern:

- **Warm - up period** of 10 - 15 minutes "loosen up" muscles and joints
- **Training stimulus period** means the activity which raises the HR to the prescribed target rate with duration of 15 - 20 minutes, aerobic exercise by a steady state.

Remember: Interruption must be made every few minutes to check the HR!

- **Cool - down period** 5 - 10 minutes
Activity is gradually lessened

Note:

- Shower taken following exercise should be warm rather than hot.
- All supervisory personnel have passed the course in cardiac resuscitations

Frequency - 3 sessions weekly

- We prefer the dynamic type of activity:
walking, running (slowly), cycling, skiing,

Note: No exercise should be done during strong cold wind.

Swimming should be practiced only in warm and shallow water, and we don't recommend a sudden attack in cold water. The suitable sports are volleyball and tennis. However the emotive rise of HR presents a certain risk here.

Home programs are especially valuable for older patients or for those who have never participated in any kind of sport for recreation. We recommend especially walking, cycling outdoors and indoors and swimming.

Conclusion

Electronic lecture presentations in sports medicine education are running in our Faculty of Medicine during 2010-2011 and are under review at the present time. Subsequently they will be available for all medical faculties throughout the Czech Republic. As an example of topics the exercise test (stress test) in patients with coronary heart diseases (CHD), or suspicious CHD were presented.



References

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