

ARRHYTHMOGENIC RISK OF EXERCISE STRESS TESTING

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Keywords: exercise test, arrhythmias, cardiovascular risk factors

Abstract: Background and purpose: In the last two decades, the indication of exercise stress testing (ET) enlarged, being used for diagnostic purposes and the evaluation of the great majority of cardiovascular patients. In the same period, the prevalence of arrhythmias significantly increased in cardiovascular patients, supporting a reevaluation of the arrhythmogenic risk of exercise stress testing. Methods: There were studied 1110 consecutively exercise stress tests, indicated for diagnosis or evaluation. There were excluded the subjects with arrhythmias at rest, immediately before ET. In the present study, there were taken into account tachyarrhythmias (except sinus tachycardia), but also conduction disturbances during and ten minutes after the ET and they were correlated with (some) cardiovascular risk factors, etiology of cardiovascular disease and left ventricular performance. Results: The studied group consisted in 1110 patients, 589 females and 521 males, aged of 55,25 +/- 9,78 years, diagnosed with ischemic heart disease (64,1%), dilated cardiomyopathy (4,1%), arrhythmias (8,92%) and healthy subjects (22,88%). A number of 421 of all patients were addressed to ET for diagnostic reason. Arrhythmias were registered during ET in 21,2% of all cases and after effort in 13,0% and conduction disturbances during ET and after effort in 2,2%. During exercise the arrhythmias were represented by ventricular premature beats (VPB) in 13%, ventricular tachycardia in 1,1%, supraventricular extrasystoles 6,7% and atrial fibrillation 0,4%. VPB weren't significantly more frequent in ischemic heart disease (12,6% vs 10,6%, p=0,14), except old myocardial infarction (24,5% vs 10,7%, p<0,001) and they were registered in 48% of the patients with LVEF <40% (vs 11,7% patients without old myocardial infarction, p<0,005). The correlation with left ventricular performance was also supported by the high incidence of VPB seen in dilated cardiomyopathy (71,1%). For VPB correlations were also registered with dyslipidemia (8,7% vs 20%, p<0,005), smoking (12,1% vs 15,8%, p<0,15), hypertension (10,8% vs 19,7%, p<0,005), obesity (29,1% vs 9,8%, p<0,001). The presence of VPB immediate after exercise is considered to have an increased arrhythmogenic risk. VPB were more frequent registered in patients with ischemic heart disease (7% vs 1%, p<0,05), dyslipidemia (19,6% vs 8,1%, p<0,005) and hypertension (6% vs 0%). The small percent of the patients who presented ventricular tachycardia don't offer the possibility of any correlation. In case of supraventricular extrasystoles, the only correlation was registered with LVEF (25% in patients with LVEF<40% vs 7% in LVEF>40%, p<0,005), which suggests that they represent a sign of depressed left ventricular systolic performance and increased mean atrial pressure. Conclusion: The arrhythmogenic risk of ET is low, being represented mainly by ventricular premature beats, correlated with left ventricular performance, old myocardial infarction and some cardiovascular risk factors. In turn, no cardiac arrhythmic death was registered during exercise stress testing.

Cuvinte cheie: test de efort, aritmii, factori de risc cardiovascular

Rezumat: Scopul studiului: In ultimii douazeci de ani indicatia efectuării testului de efort s-a largit, acesta fiind folosit atat in scop diagnostic, cat si in evaluarea pacientilor cu afectiuni cardiovasculare. In aceeasi perioada, prevalenta tulburarilor de ritm a crescut semnificativ, la pacientii cardiaci, sustinand reevaluarea riscului aritmogenic al testului de efort. Metoda: Au fost studiate 1110 teste de efort consecutive, indicate in scop diagnostic sau de evaluare. Au fost exclusi subiectii care au prezentat tulburari de ritm in repaus, imediat inaintea testului. In acest studiu au fost luate in considerare ca tulburari de ritm atat tahiaritmiiile (cu exceptia tahicardiei sinusale), cat si tulburarile de conducere si timpul testului de efort si in urmatoarele 10 minute si au fost corelate cu (unii) factori de risc cardiovascular, etiologia bolii cardiace si performanta ventriculului stang. Rezultate: Grupul studiat a constat din 1110 pacienti, 589 femei si 521 barbati, in varsta de 55,25 +/-9,78 ani, diagnosticati cu cardiopatie ischemica (64,1%), cardiomiopatie dilatativa (4,1%), antecedente de aritmii (8,92%) si subienti sanatosi (22,88%). Un numar de 421 pacienti a fost adresat la testul de efort in scop diagnostic. Tulburarile de ritm au fost inregistrate in timpul testului de efort in 21,8% din cazuri si dupa efort in 13,0% din cazuri, iar tulburarile de conducere in timpul si dupa efort au aparut la 2,2%. In timpul efortului tulburarile de ritm au fost reprezentate de extrasistole ventriculare (13%), tahicardie ventriculara (1,1%), extrasistole supraventriculare (6,7%) si fibrilatie atriala (0,4%). Extrasistolele ventriculare in timpul efortului nu au fost semnificativ mai frecvente la pacientii cu cardiopatie ischemica (12,6% vs 10,6%, p=0,14), exceptand infarctul miocardic vechi (24,5% vs 10,7%, p<0,001) si au aparut la 48% din pacientii cu FEVS <40% (vs 11,7% pacienti fara antecedente de infarct

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CLINICAL ASPECTS

miocardic, $p < 0,05$). Corelatia cu performanta ventriculara stanga a fost sustinuta si de incidenta mare a extrasistolelor ventriculare aparute la pacientii cu cardiomiopatie dilatativa (71,1%). S-au gasit de asemenea corelatii intre aparitia EV si dislipidemie (8,7% vs 20%, $p < 0,05$), fumat (12,1% vs 15,8%, $p < 0,15$), hipertensiune (10,8% vs 19,7%, $p < 0,05$), obezitate (29,1% vs 9,8%, $p < 0,001$). Prezentia EV imediat dupa efort este considerata a avea un risc aritmogenic crescut. EV postefort au fost mai frecvent intalnite la pacientii coronarieni (7% vs 1%, $p < 0,05$), dfislipidemie (19,6% vs 8,1%, $p < 0,005$) si hipertensiune (6% vs 0%). Procentul mic de pacienti care a prezentat tahicardie ventriculara nu ofera posibilitatea vreunei corelatii. In ceea ce priveste extrasistolele supraventriculare, singara corelatie a fost cea cu FEVS (25% la pacientii cu FEVS < 40% vs 7% la cei cu FEVS > 40%, $p < 0,05$), ceea ce sugereaza ca ele reprezinta un semn al performantei sistolice scazute si al cresterii presiunii medii atriale. Concluzie: Riscul aritmogen al testului de efort este mic, fiind reprezentat in special de extrasistolele ventriculare, corelate cu functia sistolica, infarctul miocardic vechi si factorii de risc cardiovasculari. In schimb, un s-a inregistrat nici un deces de cauza aritmica in timpul testului de efort..

INTRODUCTION

In the last two decades, the indication of exercise stress testing (ET) enlarged, being used for diagnostic purposes (in patients with suspected heart disease) and the evaluation of the great majority of known cardiovascular patients. Exercise testing is a noninvasive diagnostic tool, efficient and less expensive.(1)

We know that in ischemic heart disease, as well as in dilative cardiomyopathy and valvular heart disease, the prevalence of rhythm disturbances is high and they are caused by the modification of myocardial substrate (dilation of chambers, myocardial fibrosis), ischemia and neuro-hormonal activation. As for the patients with cardiac failure there are also other factors responsible for arrhythmia induction, such as: electrolytic disturbances (hypo-, hyperkalemia, hypomagnesaemia), drug interactions with contractile function and electrical stability (antiarrhythmics, digitalis, calcium channel blockers), other concomitant diseases (hyperthyroidism, respiratory diseases).(2-5)

Due to all these problems which increase the prevalence of arrhythmias in cardiovascular patients and also due to the modification of the arrhythmogenic profile of the ischemic heart disease, we thought to re-evaluate the arrhythmogenic risk of exercise stress testing.

MATERIAL AND METHOD

There were studied 1110 consecutively exercise stress tests, done in January-June 2007 in the Cardiology Department of the Rehabilitation Hospital Cluj-Napoca, indicated for diagnosis or evaluation of patients with already known cardiovascular disease.

Exercise testing was done on cycloergometer with rest ECG and blood pressure monitoring, followed by successive steps of 25 Watts, 3 minutes long each, until stopping the test due to development of symptoms or ECG modifications. Blood pressure and ECG were monitored continuously.

There were excluded the subjects with arrhythmias at rest, immediately before exercise stress test. In the present study there were taken into account tachyarrhythmias (except sinus tachycardia), represented by premature ventricular and supraventricular beats, paroxysmic supraventricular tachycardia, atrial fibrillation, ventricular tachycardia but also conduction disturbances (bundle branch block or AV block) during and ten minutes after the exercise stress test.

All the rhythm disturbances were correlated with some cardiovascular risk factors (dyslipidemia, smoking, hypertension), etiology of cardiovascular disease and left ventricular performance (limit value was 40%). Dyslipidemia was defined by one or more of the following values: total cholesterol > 200 mg%, HDL cholesterol < 40mg%, LDL cholesterol > 100mg%; hypertension was present if the value of blood pressure at admission was greater than 140/90 mmHg for

patients without diabetes mellitus and > 130/80 mmHg for diabetic patients. Patients were considered smokers if they had more than 10 cigarettes per day.

STATISTICAL ANALYSIS

The data were analyzed using SPSS 8.0 for Windows. We calculated the mean and the standard deviation for the normal distributed quantitative variables. The differences between the quantitative variables were examined using the Student test (independent-sample T test), and for the qualitative variables, we used χ^2 test. A p value less than 0.05 was considered significant from the statistical point of view.

RESULTS AND DISCUSSIONS

The studied group consisted in 1110 patients, 589 females and 521 males, aged of 55,25 +/- 9,78 years, diagnosed with ischemic heart disease (64,1%), dilated cardiomyopathy (4,1%), other cardiovascular disease, including arrhythmias (8,92%). A percent of 22,88% were healthy subjects. Patients with dilative cardiomyopathy of ischemic etiology were integrated in the ischemic group. A number of 421 of all patients were addressed to exercise stress test for diagnostic reason. Arrhythmias were registered during exercise stress test in 21,8% of all cases and after effort in 13,0%. Conduction disturbances appeared in 2,2% of the patients during exercise stress test

During the exercise, arrhythmias were represented by ventricular premature beats (VPB) (13,5%), ventricular tachycardia (1,1%), supraventricular extrasystoles (6,7%) and atrial fibrillation (0,4%).

In the group of healthy subjects, the arrhythmias during exercise test were represented only by premature beats: ventricular (10,6%) and supraventricular (3,2%).

Ventricular premature beats weren't significantly more frequent in patients with ischemic heart disease, when compared with healthy subjects (12,6% vs 10,6%, $p = 0,14$). Patients with old myocardial infarction are an exception (24,5% vs 10,7%, $p < 0,001$). Ventricular premature beats were registered in 48% of the ischemic patients with LVEF < 40% vs 11,7%, $p < 0,001$ in patients with LVEF > 40%. The correlation with left ventricular performance was also supported by the high incidence of VPB seen in dilated cardiomyopathy (71,1%).

Due to the low incidence of ventricular tachycardia at effort (1,7%) it was impossible to obtain any correlation, but it is of interest the fact that this arrhythmia was registered only in ischemic patients.

Supraventricular arrhythmias were less frequent than the ventricular ones (7,2% vs 13,5%, $p < 0,05$). They were represented by premature supraventricular beats in 6,8% of cases and atrial fibrillation in 0,4%. Their incidence is maximal in the dilative cardiomyopathy group (26,7%). For these arrhythmias the only possible correlation was the one with LVEF (25% in patients with LVEF < 40% vs 7% in LVEF > 40%,

CLINICAL ASPECTS

$p < 0,05$), which suggests that they represent a sign of depressed left ventricular systolic performance, increased LV telediastolic pressure and finally increased mean atrial pressure.

The incidence of conduction disturbances during exercise test was low (2,2%) and met only in ischemic patients. In the present study they were represented by left bundle branch block in 80% of cases and right bundle branch block in the rest of cases.

Considering the already known relationship between exercise induces arrhythmias and ischemic heart disease, we tried to show if there are also correlation with some cardiovascular risk factors.

For VPB correlations were registered with dyslipidemia (20% vs 8,7%, $p < 0,05$), smoking (15,8% vs 12,1%, $p < 0,15$), hypertension (19,7% vs 10,8%, $p < 0,01$), obesity (29,1% vs 9,8%, $p < 0,001$).

As for the supraventricular arrhythmias, premature supraventricular beats correlate with dyslipidemia (9,8% vs 2,1%, $p < 0,001$) and smoking (13% vs 6,1%, $p < 0,001$). They are present insignificantly more often in obese patients (7,6% vs 6,7%, $p > 0,05$). Atrial fibrillation had a low incidence and it was present only in smokers (4,2%) and diabetics (3,3%).

In the present study exercise induced arrhythmias are frequent in healthy subjects, with predominance of premature ventricular beats, without risk characteristics. Supraventricular ectopic beats are less frequent than the ventricular ones. In this group of patients there weren't present any arrhythmias with vital risk. These results are similar to those met in the literature, but a little smaller as percentage (27% ventricular premature beats and 5% supraventricular premature beats). A possible explanation can be the fact that, although the ECG monitoring was continuous during the test, the interpretation was done over discontinuous ECG traces with 5-6 P-QRS complexes on each step.

The patients with ischemic heart disease represented the great majority in our study (64%) and arrhythmias had the highest incidence in this group. They were mainly represented by ventricular premature beats, even with high risk criteria (couplets, salvos).

In the latest studies ventricular arrhythmias are classified in frequent and less frequent (PVC rates less than and greater than median value of all subjects included) (9-11). Ventricular tachycardia is studied separately due to its severity. The percentages in our study are also similar to that found in the recent studies, but a little smaller. In the literature PVB are found in 27% of patients with angiographic demonstrated ischemic heart disease and 9% of normal coronary artery patients; ventricular tachycardia had an incidence up to 1,5% (9-19). The explanation may be the discontinuous traces and the great number of inconclusive tests (maximal AV rates less than normal maximal calculated AV rates), knowing that arrhythmias are met at high AV rates (> 130 /minute).

Supraventricular premature beats and atrial fibrillation probably signify atrial ischemia or left ventricular failure. In different studies supraventricular extrasystoles had a prevalence of up to 24% and atrial fibrillation 0,8% (20-22).

Bundle branch block are less frequent during exercise test. Even for patients with ischemic heart disease, left bundle branch block has an incidence of 0,5% in recent studies (23). We did not see any atrio-ventricular block during exercise in our study. An important fact is that every patient who developed bundle branch block was known having ischemic heart disease.

In the present study dilative cardiomyopathy was the most arrhythmogenic of all cardiovascular disease. Ventricular beats were present in 4/5 of these patients; lack of high risk criteria is probably due to the antiarrhythmic +/- betablocking

treatment already taken by these patients.

Supraventricular arrhythmias were registered in 1/4 of dilative cardiomyopathy patients. In this pathology the left ventricular performance is low and the telediastolic ventricular and mean atrial pressures are high, so we expected an even greater incidence. From our data the great majority of patients with very low ejection fraction had already atrial fibrillation (permanent or persistent) and this was an exclusion criteria. In dilative cardiomyopathy tachyarrhythmias are predominant, while bradiarrhythmias are rare or even absent.

These data are in concordance with the ones in other studies, in which supraventricular and ventricular arrhythmias have the highest incidence in heart failure, independent of its etiology (40% and 60% respectively).

Strong data is poor regarding correlations of arrhythmias with cardiovascular risk factors. A recent study (24) demonstrated that in patients using statins the incidence of exercise induced ventricular premature beats was lower, independent of the value of serum cholesterol (9,25-26).

There are some studies showing a significant correlation between ventricular premature beats with smoking; the association with obesity was insignificant. Correlations of ventricular tachycardia (VT) with the risk factors are missing; the only well demonstrated connection is the one between VT and severity of ischemic heart disease. (13, 17, 25)

Supraventricular arrhythmias, mainly extrasystoles, correlate well with dyslipidemia and smoking, and less with diabetes mellitus. Atrial fibrillation was seen only in diabetics and smokers. A possible explanation is diastolic dysfunction and high atrial pressure in diabetic patients. In other studies are reported significant correlations between all supraventricular arrhythmias and dyslipidemia, hypertension and smoking. (6, 26)

CONCLUSIONS

In conclusion, ventricular and supraventricular premature beats are the most frequent arrhythmias during exercise test. Known arrhythmic substrate does not confer a high risk for developing arrhythmias at effort. Ischemic heart disease is the only one associated with high risk rhythm disorders, although the greatest incidence was seen in dilative cardiomyopathy.

The arrhythmogenic risk of ET is low, being represented mainly by premature beats, ventricular or supraventricular.

Exercise induced arrhythmias correlate with some cardiovascular risk factors, true especially for ventricular rhythm disorders.

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