ARRHYTHMOGENIC RISK OF EXERCISE STRESS TESTING

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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 took 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.
CLINICAL ASPECTS

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. 

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, hypomagnesaeemia), drug interactions with contractile function and electrical stability (antiarrhythmics, digitalis, calcium channel blockers), other concomitant diseases (hyperthyroidism, respiratory diseases). 

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, paroxistic 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 valur was 40%). Dyslipidemia was defined by one or more of the following values: total cholesterol > 200 mg%, HDL cholesterol < 40 mg%, LDL cholesterol >100 mg%; 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.

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 $\chi^2$ 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%).
beats were present in 4/5 of these patients; lack of high risk bundle branch block was known having ischemic heart disease. 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, salvoes).

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 incidence of conduction disturbances during exercise test was low (2,2%) and met only in ischemic 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 bradarrhythmias 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.

**REFERENCES**


