

Cardiac arrhythmias

Diagnostic and therapeutical decision

Lukl, J.

1st Clinic of Internal Medicine, Faculty Hospital, Olomouc, Czech Republic

SUMMARY

Over the last 40 years a better understanding of the mechanisms of cardiac arrhythmias has unambiguously demonstrated the therapeutical superiority of non-pharmacological treatment over antiarrhythmic drugs, which are these days used more in the acute phase or moderate forms of tachyarrhythmias. Diagnosis of bradyarrhythmias relies mainly on bradycardia symptoms, bradycardia detection on the surface ECG and their mutual time correlation. Electrophysiological studies are not so important in these cases. Permanent cardiac stimulation dominates unequivocally in the therapy of bradyarrhythmias. Electrophysiological study has come to have a unique place in tachycardia therapy, since it makes it possible to reproducibly induce tachyarrhythmia and - by means of mapping - to determine its course. Thus a completely new "intracardiac" view of the arrhythmia mechanism has evolved and considerably weakened the diagnostic importance of the surface ECG. Radiofrequency catheter ablations represent a rapidly evolving causal therapeutical modality of tachyarrhythmias, especially in the absence of structural heart disease. Significantly decreased left ventricular ejection fraction combined with tachycardia symptoms should raise the suspicion of life-threatening ventricular arrhythmias, which are nowadays successfully treated by the implantation of a cardioverter-defibrillator.

Key words: cardiac arrhythmias, diagnosis, therapy.

Čas. Lék. čes., 2005, 144, pp. 224-227.

The modern history of arrhythmia treatment is marked by four dates: first pacemaker implantation in 1958 (1), first defibrillator implantation in 1980 (2), first catheter ablation in 1982 (3) and the CAST study that was the first to pay attention to mortality consequences of antiarrhythmic drugs due to so-called proarrhythmic effect (4). The predominance of non-pharmacological treatment over antiarrhythmic drugs in arrhythmia treatment was determined much earlier. Soon after the introduction of the cardiac pacemaker (CP) into everyday practice few people recalled antiarrhythmic drugs. As well as in the area of chronic tachyarrhythmias treatment (TA) the question seems to be closed. Radiofrequency ablation (RFA) may represent the final solution in almost all TA with the exception of ventricular tachycardias (VT) in patients with serious structural heart disease (SHD) and in ventricular fibrillation (VF). These patients are treated with implantation of cardioverter-debrillator (ICD) nowadays. 12-lead surface ECG is more than 100 years old. The main contribution of modern era of arrhythmia diagnostics is the discovery of programmed stimulation (5), enabling possible tachyarrhythmias induction, their mapping and termination. It is used in connection with arrhythmia ablation. There are three levels of arrhythmia diagnostics: the level of symptoms (dyspnea, palpitations, syncope), level of surface ECG and level of electrophysiological study (EPS). It is accompanied by critical parameter, i. e. information on

serious structural heart disease (SHD), characterized mainly by ejection fraction (EF) of the left ventricle.

It is known that if a reliable case history and knowledge of ejection fraction are available, it is not often necessary to insist on exact diagnosis of arrhythmia by means of surface ECG, and arrhythmia may be diagnosed and treated promptly at an electrophysiological laboratory. Nevertheless, despite the predominance of non-pharmacological methods, antiarrhythmics remain our everyday assistant mainly in the acute phase of arrhythmia.

The aim of this report is not a review of scientific and research area of arrhythmias, but rather practical observations of an arrhythmologist, in order to present an "outside view" that would simplify diagnostic and therapeutical procedures for the non-arrhythmologists.

BRADYARRHYTHMIAS

From the three above-mentioned diagnostic levels, i.e. symptoms, ECG and EPS, the symptoms in time correlation with ECG-confirmed bradyarrhythmia remain the most important diagnostic instrument. EPS in bradyarrhythmias is of only minor significance; it is seldom a real benefit in practice. The examination assessing the recovery time of sinus node and sinoatrial conduction has only minor specificity and sensitivity. As well as

Address for correspondence:

Prof. Jan Lukl, MD.

1st Clinic of Internal Medicine, Faculty Hospital

775 20 Olomouc, I. P. Pavlova 22

Czech Republic

E-mail: jan.lukl@fnol.cz

intracardial examination of atrioventricular conduction system with location of blockade by means of hisogram, latent AV blockade has a rather auxiliary property, whose non-specificity usually have to be completed by ECG confirmation of higher-degree blockades accompanied by clinical symptoms of bradyarrhythmia.

Symptoms

The most common bradyarrhythmic symptoms are intermittent or chronic exertional dyspnea, syncope and presyncope. Fatigue is a less common symptom. Exertional dyspnea is caused by relatively low minute volume in consequence of chronotropic incompetence (insufficient increase in heart rate on exertion). Fatigue is typical for extreme bradycardias (mostly less than 40 beats/min). It is caused by minimal reserve of minute volume. Syncope due to bradyarrhythmias are almost always caused by long-lasting (more than 4 seconds) ventricular asystole, be that of sinoatrial or atrioventricular blockade. Presyncope is caused by short-lasting asystole. None of these symptoms is quite specific for bradyarrhythmias. Syncope may also accompany tachycardias, mainly ventricular ones. They can be ruled out by absence of palpitations (with exception of tachy-brady syndrome) and normal or slightly decreased EF.

Intermittent bradyarrhythmias

Their diagnosis is most difficult. The patients usually call for a doctor due to above-mentioned symptoms, ECG record is often negative, the suspicion of bradyarrhythmia may be raised by AV blockade of 1st degree or by bundle branch block, mainly bifascicular. The doctor should record ECG in the course of difficulties. It only depends on their frequency and duration, what method of detection will be chosen. If the intermittent symptoms last for more than one hour, there is high probability of detecting ECG changes in

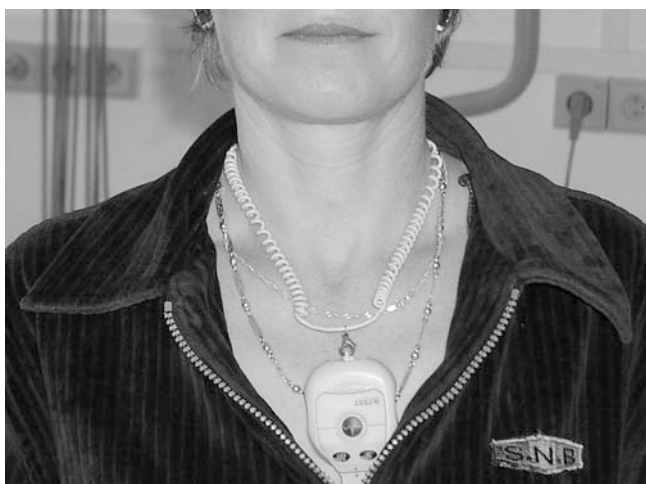


Fig. 1. ECG loop recorder (R test) for 14days ECG monitoring fixed on the patient's chest

the course of difficulties. In case of short-lasting attacks, occurring several times a week, the detection of bradyarrhythmia is rather probable using standard 24-hour ambulatory Holter ECG, which can be repeated if the record is negative. If the symptoms are less frequent than once a week, their detection is more probable by means of so-called ECG loop recorders, whose recording time reaches up to two weeks. These recording devices are available at every arrhythmological centre (Fig. 1). Even if bradycardia or asystole is recorded, their coincidence with symptoms has to be proven. Asymptomatic bradycardias and short asystolies up to 2 seconds may appear even in relatively healthy persons at sleep. The relevance of symptoms for indication of permanent cardiac pacemaker is underscored by the fact that permanent cardiac pacemaker

implantation is indicated only in bradycardia <40HB/min and asystoly longer than 3 seconds if the symptoms are absent.

Permanent bradycardias

It is much easier to diagnose them (pulse, ECG). The symptoms are mostly present, with exertional dyspnea being the most frequent. Permanent cardiac pacing is solution not only for bradycardia at rest but also for chronotropic incompetence, using so-called rate-responsive stimulation when the frequency of cardiac pacing is increased in proportion with physical exercise (7). If coincidence of bradyarrhythmia or asystoly with symptoms is detected, it is from a practical point of view more or less indifferent (necessity of treatment) if their ECG base is sinoatrial or atrioventricular blockade. As for the indication of permanent cardiac pacing, it is important to rule out the transitional causes (acute myocardial infarction, myocarditis, hyperkalemia etc.).

Tachy-brady syndrome (TBS)

This is a special form of sick sinus syndrome manifesting itself by the attack of supraventricular tachycardia (in 95% atrial fibrillation) that is after termination followed by sinoatrial (SA) blockade, often preceded by atrioventricular asystoly. The coincidence of palpitations (first symptom), followed by syncope (second symptom) is an important event in case history. Nevertheless, both symptoms may occur separately (like both arrhythmias). Echocardiography plays important role in differential diagnosis. VT may also betray itself by palpitations followed by syncope, but as opposed to TBS the occurrence of syncope is almost always linked with critically lowered EF<0.40.

Carotis sinus syndrome

Carotid sinus syndrome (CSS) is an exaggerated response to carotid sinus baroreceptor stimulation followed by increased vagus reaction as transitional bradycardia or hypotension. It should be considered in coincidence of syncope or presyncope linked with mechanical irritation in the vicinity of carotid arteries (head rotation, shaving, tightly knotted tie etc.). The diagnosis is confirmed by carotid sinus massage, performed in a sitting or standing person with concurrent ECG and BP recording.

Bradycardia in the course of vasovagal syncope

Vasovagal syncope (VVS) is abnormal reaction of circulation to the stress or warm atmosphere, mainly in upright position. Three types of VVS have been described: Cardioinhibitory type, characterized by bradycardia, vasodepressor type with predominant hypotension, and mixed type. Only cardioinhibitory type may be effectively treated by permanent cardiac pacing in 10% of cases. Most cases of VVS are pharmacologically curable (beta-blockers, aminophyllin etc.). The effectiveness of the treatment is assessed by head-up tilt test or by therapeutical experiment. The therapeutical approach is the training of repeated 10 minutes standing with support at the wall twice a day or ad hoc prevention of attack (e. g. isometric grasp of fists in prodromes).

Long-term treatment of bradyarrhythmias

In the treatment of bradycardia, after ruling out transitional causes, only permanent cardiac pacing (PCP) is used. Generally PCP is indicated in all symptomatic bradyarrhythmias and in the absence of symptoms only in the patient with asystole longer than 3 seconds, in bradycardia <40/min or in the patients with asymptomatic AV blockade of the 2nd degree of Mobitz type (constant PQ interval before QRS drop).

Resynchronization therapy – nonarrhythmic indication of permanent cardiac pacing

With the development of left ventricle dysfunction, the number

of patients with left bundle branch block (LBBB) increases, so that up to 40% of patients with EF<0.30 has LBBB at the same time (8). Abnormal course of electrical and subsequently mechanical contraction induces not only interventricular desynchronization (the right ventricle is activated sooner), but also intraventricular desynchronization, when the septal part of the left ventricle is activated as the first, and laterobasal part of the left ventricle as the last. Concomitant stimulation of the right ventricle (from the apex or from the right ventricular outflow tract) and the left ventricle (from lateral part of coronary sinus) causes resynchronization, and to a greater extent, improves the symptoms and partly mortality rate in the patients with heart failure (9).

Recently, resynchronization therapy has been indicated in this country in patients with heart failure NYHA grade III and IV, with disorder of intraventricular conduction with QRS \geq 150 ms, EF<35% and exhausted possibility of pharmacotherapy (diuretics, ACE inhibitors, beta-blockers) (6).

TACHYARRHYTHMIAS

Symptoms

The main and the most frequent symptoms are *palpitations*. Less specific but much more serious symptoms are *syncope*s and *presyncope*s. The most serious manifestation of some tachycardias is *circulation arrest*. *Dyspnea* is a frequent but less specific symptom. In patients with coronary stenosis, TA often provoke *symptoms of angina pectoris*. Analysis of history of palpitations allows the targeting of various subtypes of arrhythmias. Irregular rapid palpitations are typical for atrial fibrillation or for atrial flutter. Regular palpitations with sudden onset and suddenly terminating are typical for paroxysmal supraventricular tachycardias (SVT). Regular palpitations may occur in the beginning of monomorphic ventricular tachycardia (VT). They occur most often in patients with left ventricle dysfunction on the basis of structural heart disease (SHD). Then the most frequent symptom of ventricular tachycardia is syncope, occurring in the introduction of VT.

*Syncope*s are much more frequent symptom in VT (10) than in atrial fibrillation (FS) or SVT (about 10%-20% (11)). The protracted unconsciousness with necessary resuscitation is typical for malignant arrhythmias (very rapid monomorphic VT with low ejection fraction or with polymorphic VT and ventricular fibrillation). In supraventricular tachycardia, cardiac arrest is extremely rare (12) and it occurs only in rare coincidence with atrial fibrillation or flutter with short refractoriness of accessory pathway.

The presence of structural heart diseases and systolic dysfunction of left ventricle

Paroxysmal supraventricular tachycardias occur in the young or middle-aged and are not generally linked with serious SHD. Ejection fraction of the patients remains normal or only slightly lowered. On the contrary, in ventricular tachycardias (VT) occurring on average in the seventh decade of the life, the presence of SHD is obligatory (95%) and the critical dysfunction of the left ventricle with EF<0.40 rather characteristic (13). The most common cause of SHD is condition after large or repeated myocardial infarction (70%). The second cause is dilation cardiomyopathy (15%), followed by valvular diseases, hypertension and other diseases (about 10%). Only in 5% of VT, there are no provable diseases (10). Therefore each syncope occurring in the patient with previous myocardial infarction and EF<40% should raise a strong suspicion of VT and the patient should be urgently referred to the centre implanting ICD.

Qualified estimation of type of tachycardia on the basis of symptoms, presence of SHD and left ventricle dysfunction

In case of regular, rapid palpitations without syncope and without known SHD, there is very probably some SVT. Idiopathic VT is less probable. To confirm the benign prognosis, the involvement of left ventricle systolic function must be ruled out echocardiographically. The prognosis is favourable if EF is >0.40, even in cases of left ventricle disease. In these cases, empirical antiarrhythmic therapy may be commenced (see below). If syncope follows soon after the introductory palpitations, the patient's prognosis is less favourable and depends on the left ventricle function. Patients with normal or slightly decreased ejection fraction have better prognosis. The underlying cause may be supraventricular or, less probably, VT. Irregular palpitations or documented atrial fibrillation rather point to tachy-brady syndrome. Patients with EF<0.40 and palpitations accompanied by syncope are to be suspected of having ventricular tachycardia and as candidates of sudden death should be immediately transferred to the ICD implanting centre, without empirical pharmacotherapy.

What does ECG record mean for further decision of general practitioner?

Regular tachycardia with narrow, normal QRS is quite certainly of supraventricular origin and thus very probably suitable for radiofrequency ablation with more than 90% effectiveness. In experienced centres, the efficiency of RFA in various types of SVT is not different, and the exact determination of tachycardia on surface ECG does not figure prominently in the decision about indication of ablation. Much more important parameters in decision about how long to test pharmacotherapy are the informed approach of the patient (who should be familiar with causal character of the procedure) along with frequency of paroxysms and accompanying symptoms. As to antiarrhythmic drugs, so-called nodal blockers are used, i. e. beta-blockers, non-dihydropyridin calcium channel blockers or digoxin or IC antiarrhythmic drugs, generally propafenon. The regular tachycardia with broad QRS not explicable e. g. by previous bundle branch blockade, should on principle – for safety reasons – be assessed as ventricular tachycardia and treated as VT (14). The most frequent mistake is overestimation of SVT with aberrated QRS. In fact, only in 10-15% of cases of tachycardias are broad QRS complexes caused by aberration (15). In cases not accompanied by syncope and in normal ejection fraction, the prognosis is as favourable as it is in SVT. We need not be afraid of empirical treatment with antiarrhythmic drugs, of which propafenon or sotalol are used. In case of failure of this treatment, the patient is indicated for radiofrequency ablation. Electrophysiological examination may show whether SVT with aberration, "idiopathic VT" are present or rare antidromic atrioventricular reentry tachycardia, using accessory path in prograde direction. It does not depend on exact diagnosis of mentioned arrhythmias in indication of ablation, because the chance of the successful effect of ablation is roughly the same in all three types. On the contrary, prognosis of tachycardias with broad QRS and syncope is very unfavourable especially in patients with serious left ventricle dysfunction. The patients are jeopardized by sudden death due to malignant ventricular tachycardia in cases of any additional recurrence. Therefore the patients should be immediately sent to ICD implanting centre for diagnosis and treatment. If it is not urgent situation (accumulated relapses of VT), empirical therapy with antiarrhythmic drugs should not be commenced. This brings problems with later interpretation of the findings of EPS.

The absolute indication for transfer to the ICD implanting centre are tachyarrhythmias that lead to protracted unconsciousness with necessity for resuscitation. In these cases particularly, due to high risk of sudden death, empirical treatment with antiarrhythmic drugs and discharging the patient to aftercare is very risky.

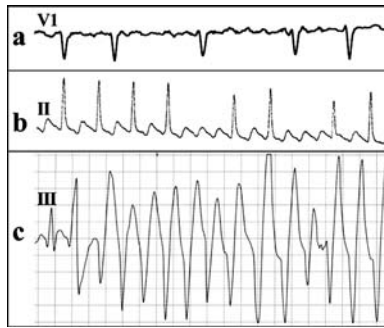


Fig. 2a. ECG record in atrial fibrillation. Ventricular complexes are irregular, P waves are replaced with fibrillation waves with frequency 600/min.

2b. ECG pattern of typical atrial flutter

In the lead II, negative flutter waves of saw-teeth shape are apparent, having frequency about 300/min. Their conduction towards the ventricles is irregular.

2c. Polymorphic ventricular tachycardia with irregularity of broad ventricular complexes of various shape

Irregular palpitations or ECG recorded irregular tachycardias are most often caused by AF, less often by irregularly conducted atrial flutter or multifocal atrial tachycardia. The most rare irregular tachycardia is polymorphic ventricular tachycardia with broad QRS complex and different QRS shape from complex to complex. On ECG, these irregular tachyarrhythmias are quite easily distinguishable (Fig. 2), which is fortunate since the strategy of treatment is very different.

On principle, atrial fibrillation is managed conservatively, i. e. pharmacologically. In asymptomatic course and in the absence of SHD, keeping heart rhythm under control should be preferred (cardioversion, propafenon, sotalol or amiodarone), in case of minor symptoms and left ventricle dysfunction, heart rate control with so-called nodal blockers is preferred. Both strategies are comparable in terms of prognosis (16). If risk factors for thromboembolic complications (age above 65 years, diabetes, hypertension, heart failure in the last month, history of ischemic stroke) are present, oral anticoagulation treatment should be always introduced. Selective ablation in AF is in the stage of clinical experiment and can be recommended mainly in symptomatic patients without serious organic heart disease.

In atrial flutter of Type I, there is the same therapeutical strategy as in regular supraventricular tachycardia. But the rule is that the first choice treatment should be RFA. It yields almost absolute long-term successfulness with infrequent complications.

The rare multifocal atrial tachycardia is not easily curable by ablation, just like atrial fibrillation. Moreover, it is often linked with serious pulmonary or cardiac disease. Polymorphic ventricular tachycardia without underlying cause (acute myocardial infarction, drugs that prolong QT interval etc.) are mostly, as atrial fibrillation, indicated to direct ICD implantation.

Abbreviations

| | |
|------|--|
| AD | - antiarrhythmic drugs |
| AF | - atrial fibrillation |
| CSS | - carotid sinus syndrome |
| EF | - ejection fraction |
| EPE | - electrophysiological examination |
| EPS | - electrophysiological study |
| ICD | - implantable cardioverter-defibrillator |
| LBBB | -left bundle branch block |
| PM | - pacemaker |
| RFA | - radiofrequency ablation |

| | |
|-----|--------------------------------|
| SHD | - structural heart disease |
| SVT | - supraventricular tachycardia |
| TA | - tachyarrhythmia |
| TBS | - tachy-brady syndrome |
| VF | - ventricular fibrillation |
| VT | - ventricular tachycardia |
| VTA | - ventricular tachyarrhythmia |
| VVS | - vasovagal syncope |

REFERENCES

1. **Elmqvist, R., Senning, A.:** An implantable pacemaker for the heart. In: Smyth, C. N.: Medical electronics, Proceeding in the second international conference on medical electronics. Paris, Iliffe and Sons, 1999.
2. **Mirowski, M., Reid, P. R., Mower, M. M. et al.:** Termination of malignant ventricular arrhythmias with an implanted automatic defibrillator in human beings. *N. Engl. J. Med.*, 1980, 303, pp. 322-324.
3. **Gallagher, J. J., Svenson, R. H., Kassel, J. H. et al.:** Catheter technique for closed-chest ablation of the atrio-ventricular conduction system: a therapeutic alternative for the treatment of refractory supraventricular tachycardia. *N. Engl. J. Med.*, 1982, 306, pp. 194-200.
4. The Cardiac Arrhythmia Suppression Trial (CAST) investigators: Preliminary report: Effect of encainide and flecainide on mortality in a randomized trial of arrhythmia suppression after myocardial infarction. *N. Engl. J. Med.*, 1989, 321, pp. 406-412.
5. **Gerritsen, J. W.:** Dutch pioneers of cardiology: FC Donders - TW Engelmann - KF Wenckebach - W Einthoven - D Durrer. *Neth. J. Cardiol.*, 1991, 4, pp. 130-139.
6. **Táborský, M.:** Zásady pro implantace kardiostimulátorů a implantabilních kardioverterů-defibrilátorů pracovní skupiny pro arytmie a kardiostimulaci České kardiologické společnosti. *Cor Vasa*, 2002, 43, pp. K32-K41.
7. **Lukl, J., Doupal, V., Heinc, P.:** Quality of life during DDD and dual sensor VVIR pacing. *PACE*, 17, 1994, p. 1844.
8. **Farwell, D., Patel, N. R., Hall, A. et al.:** How many people with heart failure are appropriate for biventricular resynchronization? *Eur. Heart J.*, 2000, 21, pp. 1246-1250.
9. **Ermis, C., Lurie, K. G. et al.:** Biventricular implantable cardioverter defibrillators improve survival compared with biventricular pacing alone in patients with severe left ventricular dysfunction. *J. Cardiovasc. Electrophysiol.*, 2004, 15, pp. 862-866.
10. **Lukl, J.:** Indikace k implantaci ICD z pohledu praktického kardiologa a internisty. In: Lukl, J.: *Moderní léčba arytmií*, Praha, Grada Publishing, 2001, pp. 47-53.
11. **Duckeck, W., Kuck, K. H.:** Syncope in supraventricular tachycardia. Incidence, pathomechanism and consequences. *HERZ*, 1993, 18, pp. 175-178.
12. **Zardin, M., Yee, R., Thakur, R. K., Klein, G. K.:** Risk of sudden arrhythmic death in the Wolff-Parkinson-White syndrome: Current perspectives. *Pacing Clin. Electrophysiol.*, 1994, 17, pp. 966-975.
13. **Bailey, J. J., Berson, A., Handelsman, H.:** Utility of current risk stratification tests for predicting major arrhythmic events after myocardial infarction. *J. A. Coll. Cardiol.*, 2001, 38, pp. 1902-1911.
14. **Buxton, A. E., Marchlinski, F. E., Doherty, J. U.:** Hazards of intravenous verapamil for sustained ventricular tachycardia. *Am. J. Cardiol.*, 1987, 59, p. 1107.
15. **Brugada P., Brugada J., Mont, L. et al.:** A new approach to the differential diagnosis of regular tachycardia with a wide QRS complex. *Circulation*, 1991, 83, pp. 1649-1659.
16. The Atrial Fibrillation Follow-up Investigation of Rhythm Management (AFIRM) investigators. A comparison of rate control and rhythm control in patients with recurrent atrial fibrillation. *N. Engl. J. Med.*, 2002, 347, pp. 1825-1833.
17. **Lip, G. Y., Hart, R. G., Conway, D. S.:** Antithrombotic therapy for atrial fibrillation. *BMJ*. 2002, 325, pp. 1022-1025.

Translation: Oldřich Louthan