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ARRHYTHMIAS IN CHILDREN

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Arrhythmias - Any deviation from normal sinus rhythm

Etiology of rhythm disturbances

- Immaturity of nodal tissue
- Malformations of nodo-hisian system
- Intrauterine viral infections
- Chronic cardiac distension with structural nodal lesions (congenital or acquired cardiopathies).

Direct myocardial diseases

- Acute myocardites
- Severe disorders of hydroelectrolytic metabolism
- Digitaline intoxication
- Tumors of myocardium
- Neuromuscular diseases
- Thyrotoxicosis or mixedema
- Collagen diseases

A. Arrhythmias in genotypical diseases:

- Mucopolysaccharido-ses
- dislipidoses,
- Cystic fibrosis,
- Marfan syndrome,
- Ehlers-Danlos syndrome

B. Familial isolated arrhythmias and conductivity disturbances:

- Paroxysmal supraventricular tachycardia with/without WPW
- AV block
- Atrial fibrillation
- Sinusal bradycardia

7. Functional disorders of nervous system
8. Diseases of nervous and vegetative system

- Ischemic disease
- Hypoxia, hypoxemia by different causes.
- Action of toxic substances on the heart

- Toxicity of medicamentous remedies
- Arrhythmias consecutive cardiac surgery
- Disorders of idiopathic rhythm

Classification of cardiac rhythm disturbances.

I. Disturbances of impulse forming

A. Disturbance of sinusal node automatism

- Sinusal tachycardia
- Sinusal bradycardia
- Sinusal arrhythmia
- Intracardiac migratory center
- Sick sinusal node syndrome

B. Arrhythmias with heterotopic automatism predominance:

- **Extrasystoles : atrial, nodal, ventricular, allorhythmic, precocious and tardive, polytopic, polymorphous.**
- **Paroxysmal supraventricular (atrial or atrioventricular), ventricular tachycardia.**
- **Nonparoxysmal atrioventricular (atrial with or without block) and ventricular tachycardia.**
- **Atrial flutter**
- **Atrial fibrillation**
- **Flutter and ventricular fibrillation**

II Disturbances of impulse conducting

- Sinoatrial block
- Interatrial block
- Block by I degree
- Block by II degree
- Block by III degree: supra-, intra- or infrahisian
- Mono-, bi-, trifascicular intraventricular blocks

III. Impulse forming and conducting associated disturbances.

- Atrioventricular dissociation
- Parasystole
- Preexcitation syndrome.

Classification of arrhythmias by E. P. Walsh

1. Premature beats (extrasystoles)



Atrial



Ventricular

2. Tachycardias.

- **Supraventricular tachycardia**
 - **Atrial flutter**
 - **Atrial fibrillation**
 - **Ectopic atrial tachycardia**
 - **Multifocal atrial tachycardia**
 - **Reentrant nodal atrioventricular tachycardia**
 - **Reentrant tachycardia via WPW**
 - **Reentrant tachycardia via accessory pathways**

■ **Ventricular Tachycardias**

- Ventricular tachycardia by monomorphic reentrance
- Ventricular tachycardia by polymorphous reentrance
- Ventricular tachycardia by focus of automatism (focal)
- Torsades de pointes (“twisting of the points”)

3. Bradycardia

- Sinus bradycardia
- “Tachy-Brady” syndrome (sick sinus node syndrome)
- Atrioventricular block
 - I degree
 - II degree Mobitz I
 - II degree Mobitz II
 - III degree - congenital
 - III degree - acquired

Principles of rhythm disturbances diagnosis.

1. The goal.

- ECG recordings
- Diagnosis of cardiac disease: kind of disease, assessment of ventricular function disturbance, severity of basic cardiac disease.
- Looking for some extracardiac factors that can release or maintain an arrhythmia (electrolytic imbalance).

5. Paraclinical diagnosis of arrhythmias.

- ECG in rest: 12 leads, on the paper 25-50 mm/s;
- Esophageal ECG: bipolar leads of ECG with esophageal electrodes. Indicated in brady- or tachycardic rhythms. Especially indicated for arrhythmic accidents, when the intracardiac lead is not possible;
- Long term ECG (Holter - Monitoring): allows to distinguish the arrhythmia on ECG, the frequency of arrhythmic episodes;
- ECG at effort;

- The test of carotidian compession and atropine test;
- The basic analyses including the serum level of drugs.

Invasive

- Intracardiac ECG, hisiogram, programmed stimulation of atrium and ventricle.

Imagistic investigations

- Echographic examination:
 - Foetal
 - In arrhythmias in congenital and acquired cardiomyopathies
- 2. Computer tomography;
- 3. Magnetic nuclear resonance;
- 4. Radionuclide angiocardiography;
- Cardiac catheterism;

All these have a great value in the finding and assessment of congenital and acquired cardiomyopathies.

pre - and pubertar disturbances .

PAROXYSTIC SUPRAVENTRICULAR TACHYCARDIAS

paroxystic supraventricular tachycardias can be classified in function of their producing mechanism

:

- Reentrance through some accessory pathway;
- Reentrance without accessory pathway;
- tachycardia through automatism.

Incidence

- The supraventricular paroxystic tachycardia (SVPT) is the most common arrhythmia in children!
- Its incidence is estimated 1 to 250 children.
- The most affected age group seems to be under the 1 year age although there is also the age group the less diagnosed due to impossibility to describe the symptomatology by the patient.
- The preexcitation syndromes are more frequent in little ages after that there is observing a partial involution of these pathways.

Atrial tachycardia

- Radiologically – marked cardiomegaly.
- ECG
 - the fast atrial frequency is equal to ventricular frequency - 160 - 260 – 360/min,
 - atrial fixed activity,
 - regular P-P interval ,
 - P wave - flattened, notched, biphasic or negative followed by N QRS complexe,
 - ST segment putted out of level,

- T wave - flattened or negative.

Junctional tachycardias

reciprocal and hisian forms .

- These reciprocal have at basis the phenomenon of reentrance, which is realizing through longitudinal dissociation of conducting pathways, through the use of accessory pathways.
- Hisian tachycardias are the consequence of some ectopic foci situated in the trunk of His bundle.
The ectopic focus situated in His bundle produces depolarization with high frequency of ventricles, and atrial activity is making retrogradely. The block of activation sometimes at the atrioventricular node level allows the taking again of sinus node activity.

The clinical picture of SVPT crises is determined by:

- Patient's age;
- Duration and frequency of SVPT crisis;
- Association of congenital heart disease;
- Presence of concomitant cardiomyopathy.

Clinical picture:

- **Intrauterine** – repeated crises lead to fetoplacental anasarca.
- **In newborns** and sucklings insidious debut, loss of appetite, pallor, vomiting, agitation, tachypnea, dyspnea, cyanosis, convulsions, fatigue during alimentation, fever. Appearance of cardiac failure after 24-48 hours; without treatment the metabolic acidosis, hypoglycemia, hypernitrogenemia, hyperpotasemia, cardiomegalia (especially in the first months of life) are developing.

The symptomatology of SVPT crisis depends from the patient's age:

Under 1 year age:

- Described symptomatology reflects the general state alteration and is not specific for cardiovascular system.
- These phenomena appear in SVPT crises lasting more 24 hours, with increased frequencies more than 280/min or in the case of their association with congenital heart malformations or cardiomyopathies.

Age of 1-6 years:

- The symptomatology is relatively poor;
- State of psychomotor agitation, loss of appetite, nausea, vomits, abdominal pains especially in the case of prolonged crises with phenomena of incipient cardiac failure.
- The patient is hospitalized for intercurrent respiratory febrile affection and after decreasing of temperature the persistence of discordant tachycardia with thermic curve is observing;

More than 6 years age:

- The children begin to relate the sudden appearance of palpitations with fast rhythm, connected

with physical effort performing.

- They frequently relate the feeling of lump in throat, headache and rarely syncope – especially in the cases of atrial fibrillation with antidromic transmission.

- The presence of syncope must rise the suspicion of ventricular tachycardia episode.

CLASSIFICATION OF ANTIARRHYTHMIC DRUGS

Class 1 Fast sodium channels blockers

A Reduce moderately the speed of depolarization and repolarization:

- Quinidine;
- Novocainamide;
- Disopyramide (Ritmilen);
- Ghiluritmal (Aimalin);

B Weakly influence the depolarization speed, shorten the repolarization:

- Lidocaine
- Mexitil
- Diphenine.

C Reduce substantially the depolarization speed, have minimal effect on repolarization:

- Etacizine;
- Propafenone (Ritmonorm);
- Flecainide;
- Enoainide;
- Etmozine (Morcizine).

CLASSIFICATION OF ANTIARRHYTHMIC DRUGS:

Class 2 beta-adrenergic receptors blockers:

- Propranolol (obsidine, anapriline);
- Metaprolol;
- Atenolol.

Class 3 The drugs prolonging the duration of action potential:

- Amiodarone (cordarone);
- Sotalol
- Bretilium tosilate;
- Ibutilide;
- Dofetilide.

■ *Class 4 Calcium channels blockers:*

- Verapamil,
- Diltiazem

■ *Class 5: adenosine*

■ *Class 6: digoxin*

The treatment of supraventricular tachycardias conformable to WHO:

Step I

- Vagal stimulation–Valsalva’s manoeuvre
- Ice bags on forehead and face

- Submerging of face (head) in cool water

Step II after 1-2 min

- Administration of ATP in children after 3 years 3-5 mg i.v. in bolus with 20 ml of physiologic solution;
- In the absence of effect after 1-2 min. to repeat ATP 10 mg i.v in bolus 3-5 min 2 times.
- If the access is not stopping- passing to the

WPW syndrome

WPW syndrome with delta-wave present in all leads and left lateral localizing

The diagnosis of WPW syndrome on surface electrocardiogram:

- Short PR interval $< 0,12$ s;
- Presence of A wave with QRS complex $> 0,12$ s;
- Modifications of ST segment and T wave - which are in general opposite to A wave vector.
- In function of A wave polarity (positive or negative) on surface ECG anatomically the accessory fascicle can be localized.

Emergency treatment in SVPT crisis

- The first administered drug is adenosine in dose of 0,1 mg/kg.
- In the case of administration through peripheral vein by small diameter, the dose can be slightly increased to 0,15 mg/kg, with possibility to repeat the dose over 10 minutes without to exceed 0,4 mg/kg or 12 mg totally(see emergency treatment).
- In the case of failure the propafenone, amiodarone or antiarrhythmics of I C class are administered i/v.
- It is recommended to avoid the calcium channels blockers and β -blockers in all ages , but especially in children under 3 years age.

Tachycardia through reentrance in AV node with ventricular frequency which determinines the right branch block and left hemiblock in a13 years age child

Drug therapy.

- identical to that of supraventricular tachycardia through reentrance in atrioventricular node.

Drug treatment

- The tachycardias through atrial automatism are difficult to treat.
- Antiarrhythmics by I C class, sotalol and amiodarone are the most efficient.

Atrial flutter

- There is a form of atrial tachycardia with regular rhythm in which on ECG the atrial activity is shown as flutter waves with the aspect of saw teeth.
- The atrial frequency is 300/min in adult and big child and can achieve in newborn and baby 350-500/min.

In function of F wave aspect on ECG a lot of flutter types can be distinguished:

- type I – the flutter waves have negative significant component in DII, DIII, aVF that shows an atrial activity getting from inferior to superior;
- type II – the flutter waves are positive in DII, DIII, aVF having the significance of activation

from superior to inferior.

Mechanism of producing:

- The best explainings of atrial flutter mechanism are: microreentrance, intramyocardic reentrance and macroreentrance.

Atrial flutter with conducting 1:1 in a 10 years child.

The symptomatology of atrial flutter

- Garson (1985) has demonstrated, that only 7,6% patients presented normal heart, another presented congenital heart malformations- transposition of great vessels 20,5%, unique ventricle 17,8%, atrial septal defect 12,1%, 80% *ostium secundum*, pulmonary stenosis with or without ventricular septal defect, tetralogy of Fallot, dilatative cardiomyopathy 15,8%, complete atrioventricular channel 15%.
- Another great category from investigated patients: operated congenital heart malformations- 60,4% from all patients. The majority of cases were described after Mustard or Senning intervention - 27,6%, Blalock Hanlen -16,1%, closing of ASD 11,1%, pulmonary atresia or tetralogy of Fallot 7,9%.
- The most frequent symptoms in patients more 1 year age were: dyspnea, palpitations with rapid rhythm, syncope and swoon.
- Echocardiographic examination shows in these patients dilated atria and decreased ejection fraction of left ventricle.

The treatment has 3 objects:

- Stopping the atrial flutter
- Prophylaxis of recurrences
- Diminishing of symptomatology during recurrences

Treatment : digoxin sometimes is associated with quinidine sulphate 15 - 60 mg per os until positive effect, or novocainamide 1,5 - 2 mg / kg / i / v - 10 -30 min.

- The actual methods are: the esophageal or intraatrial overdrive pacing, flutter cardioversion, in the absence of effect – only digoxin or in association with amiodarone. For fast response on ventricular control Ca channels blockers and beta – blockers (esmolol) are administered. Prophylaxis 6 -9 months with digoxin, amiodarone. The prognosis depends from the main disease(postoperatoriy lesions with valvular regurgitations).

Atrial fibrillation

- Atrial arrhythmia 400 - 600 / min.
- It appears in severe cardiac affections with atrial dilatation, hyperthyroidism, WPW syndrome, rheumatismal cardites.
- ECG: anarchical cardiac contractions, different by form, duration and amplitude. Irregular atrioventricular conduction, normal QRS.

Treatment: Digoxin, anticoagulant treatment with prothrombin time control (trombostop – the attack dose 12 - 18 mg/day, maintenance dose 2-6 mg/day once), fenilin - oral 1-2 mg / kg / day, or amiodarone i/v 5-10mg/kg, or amiodarone per os in dependence of age (in adolescents 1200-1600 in paroxysmic crisis).

Ablation with radiofrequency currents,
Heart defibrillation.

Mechanisms

- Existence of some critical mass of atrial tissue.
- Duration of refractory atrial period;
- Speed of atrial conduction.
- Presence of accessory pathways in WPW syndrome.

Conformable to WHO

Step I.

- **Verapamil 0,1-0,2 mg/kg i/v bolus 1-2 min, after 15 min to repeat;**
- **or Diltiazem 0,25 mg/kg i/v bolus in the course of 2 min;**
- **or Atenolol 0,1-0,2 mg/kg i/v bolus - 5 min, after 10 min to repeat;**
- **or Metoprolol 0,1-0,2 mg/kg bolus - 5 min, to repeat every 5 min.**
- **or Propranolol 0,05-0,15 mg/kg i/v - 10 min, can be repeated.**

Step II

- **after 30 min. – chemical cardioversion. Novocainamide 1,5-2 mg/kg i/v in the course of 10-30 min.**

Step III.

- **Synchronized cardioversion.**

Ventricular fibrillation

- It presents a severe disorganization of cardiac activity, determined by archaic and chaotic cardiac contractions of ventricular fibres. The spontaneous tendency to stopping is absent, in the absence of urgent medical intervention the evolution is fatal.

- The ventricular fibrillation presents irregular waves, with amplitude under 0,2 millivolts – (sometimes the differential diagnosis with asystola is difficult).

Ventricular fibrillation

- In children ventricular fibrillation can appear on the normal heart in conditions of hypoxia, electrocution, thoracic traumatism, hypothermia, but in majority of cases is producing in the presence of some structural cardiac disease.
- ECG: oscillations by irregular form and amplitude.
- Frequency of oscillations 300-600/min.
- The normal electric activity is absent.

Treatment. Cardioversion. Correction of acidosis and hypoxia. Lidocaine 1 mg/kg/ i/v in bolus associated with perfusion 10-50 mg/kg.

Treatment

- It is beginning with administration of electric external unsynchronized shock – 1-2 watts-sec/kg, if the patient is monitored;
- The classic treatment of cardiopulmonary resuscitation is applying if the defibrillation equipment is absent.
- In ventricular fibrillation resistant to external electric shock the administration of bretilium

tosilate, izoproterenol, calcium channels blockers (verapamil) or cardiac defibrillation with placing of one electrode in the right ventricle with giving of 2 watts/sec/kg can be used.

- The initial medical undertaking for prevention of recurrences includes administration of lidocaine – 1 mg/kg/minute; bretilium tosylate or amiodarone, sometimes being necessary the cardioresuscitator implantation for recurrences prevention.

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