Atrial Fibrillation (AF) — Symptoms and ECG

Atrial fibrillation is the most common form of supraventricular arrhythmia. In its chronic form, it poses an increased risk of thromboembolic events, especially for people in advanced age. As this disease entails a reduced quality of life and increased mortality for the affected individuals, it is of the utmost importance that a physician knows the different forms of this widespread disease very well as to be able to make the opportune treatment decisions. The following article will provide you with an overview of the underlying mechanisms of disease and different treatment approaches.

Definition of Atrial Fibrillation

Atrial fibrillation: a form of tachyarrhythmia

Atrial fibrillation (AF) is a very common and often chronic supraventricular tachyarrhythmia. It is characterized by irregular QRS complexes and a loss of synchronous atrial contraction.

Epidemiology of Atrial Fibrillation

Atrial fibrillation is a widespread disease

About 1-2% of the general population will experience an episode of atrial fibrillation, which makes it the most common type of cardiac arrhythmia. The incidence of AF increases with age, with up to 10% of the population over the age of 70. Men are more
often affected than women.

Etiology of Atrial Fibrillation

Causes of atrial fibrillation

A distinction is made between primary (idiopathic) atrial fibrillation and secondary atrial fibrillation. Idiopathic AF describes atrial fibrillation in individuals without any other cardiac diseases and accounts for about 15 to 30% of AF cases.

Secondary AF is caused by underlying diseases; these may be of cardiac or non-cardiac nature. The most frequent cardiac cause of AF is a mitral valve defect. Other possible cardiac causes include advanced cardiac insufficiency, coronary heart disease or a myocardial infarction.

Among the non-cardiac causes of AF are arterial hypertension, hyperthyroidism or toxic substances such as alcohol, thyroxine, triptans, theophylline or sildenafil. An acute atrial fibrillation that occurs in an otherwise healthy person after an excessive consumption of alcohol is also called holiday heart syndrome.

Pathology and Pathophysiology of Atrial Fibrillation

Atrial fibrillation due to a reentrant atrial tachycardia

The arrhythmia of atrial fibrillation is caused by a reentrant tachycardia of the atria, mostly around the pulmonary veins. This means that the electrical impulses do not propagate in the normal physiological manner, i.e. starting at the sinus node, moving through the atria, and into the ventricles; rather, they repetitively move in a circular path inside the atria, which continuously depolarizes the atrial myocardium. This results in an atrial frequency of 350-600 per minute.

As the myocardium is now contracting in an asynchronous manner, the atria can no longer effectively fulfill their pumping function. This, in turn, leads to a reduced cardiac output by 15% in healthy individuals, and even more in patients with a pre-existing cardiac insufficiency. Because the AV node acts as a kind of blocker, not every excitation of the atria is conducted to the ventricles. The transmitted, often irregular ventricular
frequency, ranges mostly from 100 to 160 beats per minute.

**Symptoms and Clinical Manifestations of Atrial Fibrillation**

**Different forms of atrial fibrillation**

With regard to the progression of the disease, the following forms of AF can be distinguished, which all manifest with different symptoms:

- **First-time manifestation of AF**: often a singular event
- **Paroxysmal AF**: episodes stop on their own without treatment, mostly within less than 48 hours, 7 days at the most
- **Persistent AF**: does not stop by itself, but interventions can bring the heart back to its normal sinus rhythm
- **Permanent AF**: a chronic condition that cannot be treated

**Clinical Symptoms of Atrial Fibrillation**

For many patients with persistent or permanent AF, the disease often remains **asymptomatic** as the reduced cardiac output can be easily compensated as long as there is no unusual strain.

However, in cases of increasing cardiac insufficiency, physical strains, or paroxysmal atrial fibrillation, symptoms are more likely to manifest. These include **tachycardia** with **palpitations**, **syncope**, **dizziness**, **irregular heartbeat** and **exertional dyspnea**. In addition, patients who do not know what is causing their condition also might react with panic. Another very characteristic symptom of supraventricular arrhythmias is **polyuria** (excessive urination), which can be explained by the increased production of ANP.

**Stroke risk stratification**

Another crucial complication associated with atrial fibrillation is the **risk of thromboembolic events**. This risk can be quantified using the **CHA2DS2-VASc score**.

<table>
<thead>
<tr>
<th>C</th>
<th>Congestive heart failure</th>
<th>1</th>
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<tbody>
<tr>
<td>H</td>
<td>Hypertension</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>Age (≥ 75 years)</td>
<td>2</td>
</tr>
<tr>
<td>D</td>
<td>Diabetes mellitus</td>
<td>1</td>
</tr>
<tr>
<td>S</td>
<td>Stroke or TIA</td>
<td>2</td>
</tr>
<tr>
<td>V</td>
<td>Vascular disease history</td>
<td>1</td>
</tr>
<tr>
<td>A</td>
<td>Age 65 – 74 years</td>
<td>1</td>
</tr>
<tr>
<td>Sc</td>
<td>Sex category (female sex)</td>
<td>1</td>
</tr>
</tbody>
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**Score | Annual stroke risk %**
--- | ---
1   | 1.3  
2   | 2.2  
3   | 3.2  
4   | 4.0  

The risk factors ‘previous stroke’ and ‘age ≥ 75’ have double weight, which is indicated in the acronym as a subscript 2.

Diagnostics of Atrial Fibrillation

ECG characteristics for detecting atrial fibrillation

In the diagnostic process, the first suspicion usually arises from a history of repeated palpitations or episodes of tachycardia. In this case, it is especially important to inquire about duration, frequency and triggering factors of the AF. Furthermore, underlying diseases like, e.g., hyperthyroidism may indicate the presence of secondary atrial fibrillation.

The clinical examination may be notable for an irregular heartbeat, a variable intensity of the first heart sound, and a difference between the auscultated heart rate and the palpable peripheral pulse (pulse deficit). However, unremarkable findings do not rule out the presence of AF.

The most important diagnostic measure for confirming a suspected AF is an electrocardiogram (ECG). AF can also be a coincidental finding in a routine ECG. A first criterion would be no discernible P waves as there is no synchronous atrial excitation. Furthermore, the ECG often shows irregular R-R intervals, which is due to the irregular conduction in the AV node.

Based on the ventricular frequency, a further distinction in tachycardia (more than 100 beats per minute) and bradycardia (less than 60 beats per minute) can be made. Besides these phenomena, fibrillatory waves may be visible in lead V1, which is also caused by the asynchronous excitation. QRS complexes are typically narrow in patients with AF.
A positive ECG finding is sufficient to confirm the diagnosis. In order to detect episodes of paroxysmal AF, long-term ECG monitoring for several days with a portable ECG monitor or event recorders may be helpful.

Differential Diagnosis of Atrial Fibrillation

Distinguishing atrial fibrillation and atrial flutter

The most important differential diagnosis of atrial fibrillation is atrial flutter; both types of arrhythmia show very similar symptoms. A typical sign in the ECG of atrial flutter is flutter waves, caused by a macro-reentrant circuit in the atria. They have the form of a saw-tooth pattern.

Type I atrial flutter (also known as typical or common atrial flutter) is characterized by negative flutter waves in the ECG and a frequency of 250–350 beats per minute; the less common type II atrial flutter (reverse typical atrial flutter) shows positive flutter waves with a frequency of 250–450 bpm. Treatment is causal, consisting either in trying to convert the arrhythmia or in radiofrequency ablation.

When the ECG shows a ventricular arrhythmia, the possibility of ventricular extrasystoles has to be considered.

Treatment of Atrial Fibrillation

The first goal in treating atrial fibrillation is identifying any causal factors that may trigger the arrhythmia and to treat those. If there is no specific event or underlying
disease that causes AF, then there are two basic approaches to treatment. These are **rhythm control** for restoring the sinus rhythm and **rate control** for reducing the heart rate to a normal level. This kind of treatment is supplemented with effective **prevention of thromboembolism**.

**Rhythm control in atrial fibrillation**

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First-time atrial fibrillation will mostly be treated by trying to **control the sinus rhythm**. Restoring the atrial fibrillation to a regular sinus rhythm is called **cardioversion**. Regarding long-term benefits, rhythm control can yield similar results to rate control; however, there are some requirements to be met. Rhythm control is a suitable treatment for patients who have only recently started to exhibit atrial fibrillation (less than 12 months) and have no severe, advanced heart disease.

If the atrial fibrillation has persisted for more than 48 hours, it is crucial to rule out the possibility of a thrombus before cardioversion is performed as a thrombus could lead to an embolism when the atria start contracting again. Excluding a thrombus is done by echocardiography; if the result is positive, the patient has to be administered anticoagulation medication for a sufficient amount of time in order to assure a reliable anticoagulation.

Procedures of rhythm control are either chemical cardioversion or electrical cardioversion. **Chemical cardioversion** is used for patients without any cardiac disorders and involves the administration of drugs; mostly **class Ic antiarrhythmic agents** like, for example, **flecainide**. In case the patient has any known pre-existing cardiac conditions, the more effective **amiodarone** can be administered, which, however, carries a greater risk of side-effects. For this reason, amiodarone should only be administered to in-patients.

If the patient does not respond to medication or if there is the risk of a cardiogenic shock, **synchronized electrical cardioversion** can be performed. In this procedure, low-energy shocks of 200 J are given to the sedated patient, the timing of which is controlled by an integrated ECG as to assure the optimal moment in the cardiac cycle (synchronization). The rate of recurrence of electrical cardioversion is up to 75% within
the first year, which is why long-term antiarrhythmics are prescribed as recurrence prevention. Other more invasive options, especially for younger patients, are aimed at destroying the area of cardiac tissue that is causing the reentry mechanism either by catheter ablation or surgery.

Rate control in atrial fibrillation

Rate control is aimed at normalizing the ventricular heart rate in cases of tachycardia or bradycardia. The tachycardia caused by atrial fibrillation is usually treated with beta blockers or calcium channel blockers such as verapamil. Importantly, these two substances must not be administered together as this could cause an AV block.

Digitalis (digoxin) is sometimes given to patients with cardiac insufficiency in addition to beta blockers. However, recent studies have indicated that digitalis treatment is connected to a higher mortality in patients. In acute situations, drug-based rate control is also used to bridge the time until a cardioversion can be performed. Patients with bradycardia can benefit from a pacemaker, for example, a VVI device.

Thromboembolism prevention in atrial fibrillation

The prevention of thromboembolism in patients with atrial fibrillation is of the utmost importance because of their increased risk of embolic events, especially a stroke. This risk is assessed using the CHA2DS2-VASc score of the European Society of Cardiology (ESC). In cases of non-valvular AF, a score of 0 indicates a low risk and does not necessarily require anticoagulation.

However, even with a moderate risk (CHA2DS2-VASc of 1 or more) permanent anticoagulation will have to be considered – except if the risk factor is only based on the female gender. With a score of 2 or more in the risk stratification, anticoagulation is imperative.

In the U.S., most patients are treated with the anticoagulant warfarin (brand name Coumadin), which requires regular checks and monitoring of the target INR level of 2–3. There are also newer oral anticoagulants available which have proven to be effective. These include dabigatran, rivaroxaban, and apixaban, which each act as direct inhibitors of a specific coagulant factor.

Disease progression and prognosis

The prognosis for atrial fibrillation strongly depends on the underlying diseases and the cardiac function. Furthermore, it is particularly the risk for thromboembolic events that determine the course and the mortality of the disease. The different treatment approaches, rhythm control or rate control, do not influence the prognosis, except for patients with cardiac insufficiency, who benefit more from an ongoing rhythm control. The stroke risk can be reduced by about 60% through the proper dosages of anticoagulation.

Review Questions

Solutions can be found below the references.

1. Which ECG result is not typical of atrial fibrillation?
   A. Absent P-wave
B. Saw-tooth pattern
C. Tachycardia
D. Irregular R-R intervals
E. Bradycardia

2. What is used for rhythm control in AF?

A. Digitalis
B. Beta-blockers
C. Flecainide
D. Marcumar
E. Verapamil

3. Which of the following is not a typical symptom of atrial fibrillation?

A. Exertional dyspnea
B. Thromboembolic stroke
C. Syncope
D. Sensory disturbances
E. Cardiac irregularity

References


Correct answers: 1B, 2C, 3D

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