CENTRAL ILLUSTRATION: Absolute Coronary Flow and Resistance in Patients With Ischemia and Nonobstructive Coronary Artery Disease

84 Patients with INOCA and Suspected Vasomotor Dysfunction Completed a Coronary Function Test That Included

1. Spasm Test
using acetylcholine

73 patients (87%) had coronary spasm (ACH+)

Coronary epicardial or microvascular spasm

2. Microvascular Function Test
using adenosine

30 patients (36%) had microvascular dysfunction (ADE+)

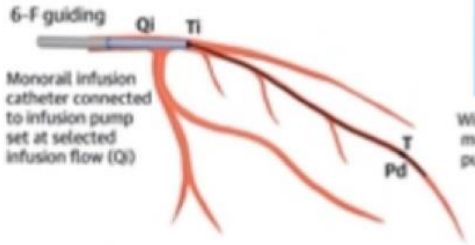
CFR <2.0 (n = 8) and/or IMR ≥25 (n = 24)

3. Novel Indices of Flow (Q) and Resistance (R)

median Q 198 ml/min (IQR 155-240 ml/min)

median R 416 ml/min (IQR 137-558 ml/min)

Novel Indices Using Continuous Thermodilution with Room-Temperature Saline to Induce Hyperemia

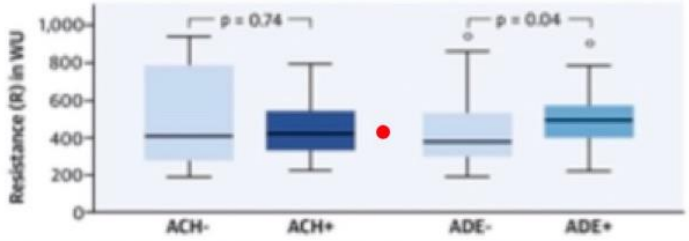


$$\text{Absolute flow (Q)} = Qi \frac{Ti}{T} 1.08$$

$$\text{Absolute resistance (R)} = \frac{Pd}{Q}$$

Wire with distal pressure/temperature sensor to measure distal coronary temperature (T), then pullback into the infusion catheter to measure the infusion temperature (Ti)

Novel Indices Vs. Spasm and Microvascular Function Test Results



R is Higher in Patients with Microvascular Dysfunction Not in Patients with Coronary Spasm

Konst, R.E. et al. J Am Coll Cardiol. 2021;77(6):728-41.

A 63-year-old otherwise healthy man is discovered to have atrial fibrillation during an evaluation for a viral respiratory infection. He reports that 3 months earlier he began noticing occasional dyspnea on climbing stairs, and this symptom has been persistent for the past month. On physical examination, the body-mass index (BMI; the weight in kilograms divided by the square of the height in meters) is 29, the blood pressure is 142/88 mm Hg, the pulse is irregular at 120 beats per minute, and there are irregular first and second heart sounds. Electrocardiographic (ECG) evaluation shows atrial fibrillation, normal QRS complexes, and a ventricular rate of 110 beats per minute. How would you evaluate and treat this patient?

- **Parossistica**: quando gli episodi si presentano e si risolvono spontaneamente in un tempo inferiore a una settimana.
- **Persistente**: quando l'episodio aritmico non si interrompe spontaneamente ma solo a seguito di interventi terapeutici esterni.
- **Permanente**: quando non siano ritenuti opportuni tentativi di cardioversione, o gli interventi terapeutici si siano dimostrati inefficaci.

- FA di PRIMO RISCONTRO: quando l'aritmia viene diagnostica per la prima volta nella storia clinica del paziente

- FA PAROSSISTICA: quando l'aritmia si interrompe spontaneamente entro 7 giorni (generalmente termina entro 24-48 ore) dall'inizio dell'episodio[3,4].

- FA PERSISTENTE: quando l'aritmia dura da più di 7 giorni e richiede un intervento terapeutico per poter ripristinare il ritmo sinusale (cardioversione elettrica o farmacologica). La FA PERSISTENTE viene definita di LUNGA DURATA, se l'aritmia è presente da più di 1 anno quando si decide di attuare la strategia di controllo del ritmo.

- FA PERMANENTE, quando il ritmo sinusale non è ripristinabile o si è accettata la presenza dell'aritmia. Qualora si dovesse tentare la cardioversione, la fibrillazione atriale andrebbe classificata nella categoria precedente .

- FA SILENTE, quando l'aritmia viene diagnostica incidentalmente attraverso un tracciato elettrocardiografico o si rende manifesta con

The Clinical Problem

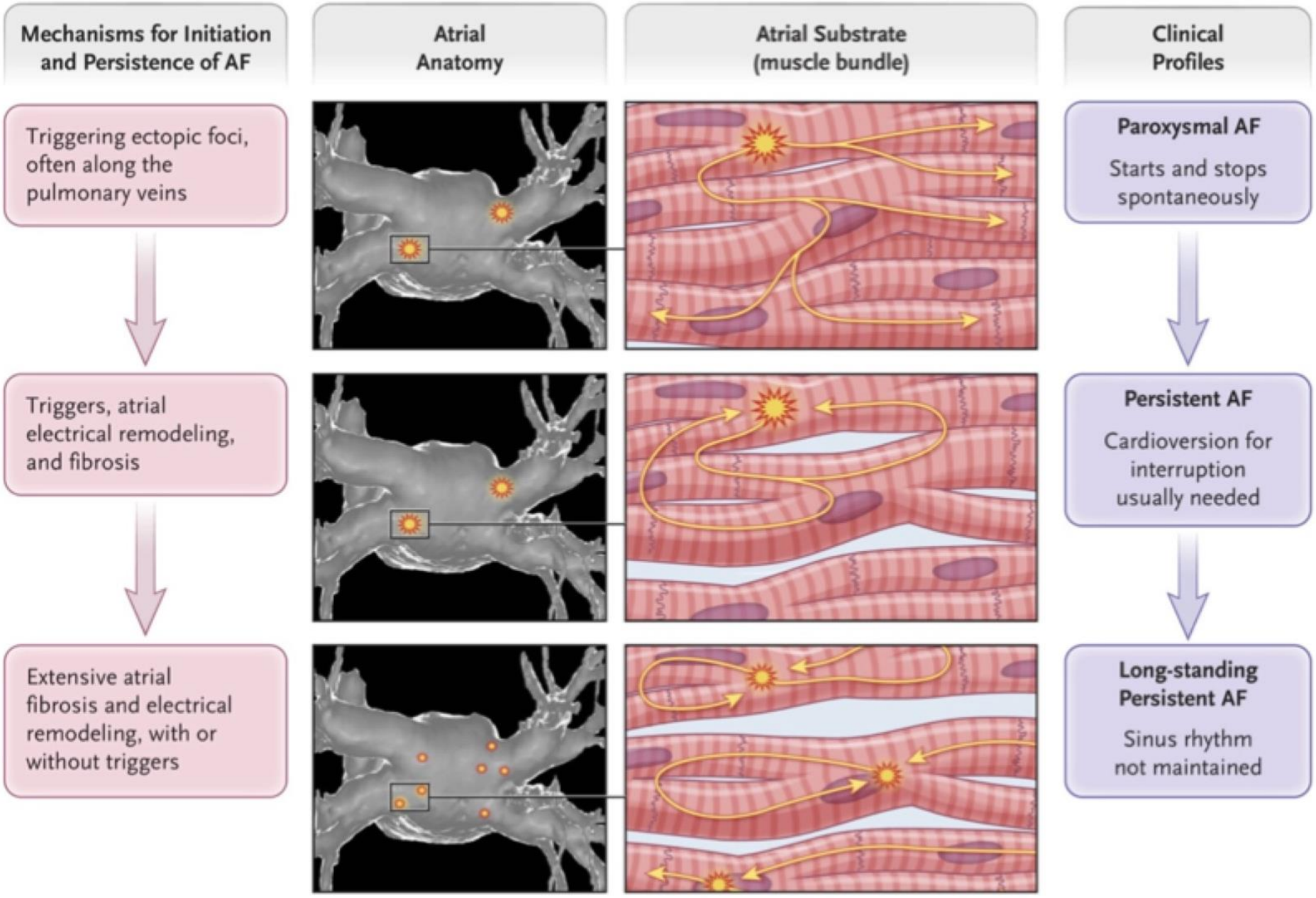
In clinical practice, atrial fibrillation is the most common sustained arrhythmia encountered in adults. Among patients in the Framingham Heart Study population, atrial fibrillation developed in 37% after the age of 55 years in those who reached that age.[1-3] Risk factors include older age, coronary artery disease, male sex, European ancestry, hypertension, obesity, smoking, diabetes mellitus, obstructive sleep apnea, and a family history of atrial fibrillation in a first-degree relative.[4] In a large multi-institutional study, 19% of the patients with newly diagnosed atrial fibrillation had an acute precipitant such as pneumonia or surgery (the two most common precipitants), myocardial infarction, pulmonary embolism, thyrotoxicosis, or alcohol intoxication.[5]

KEY CLINICAL POINTS

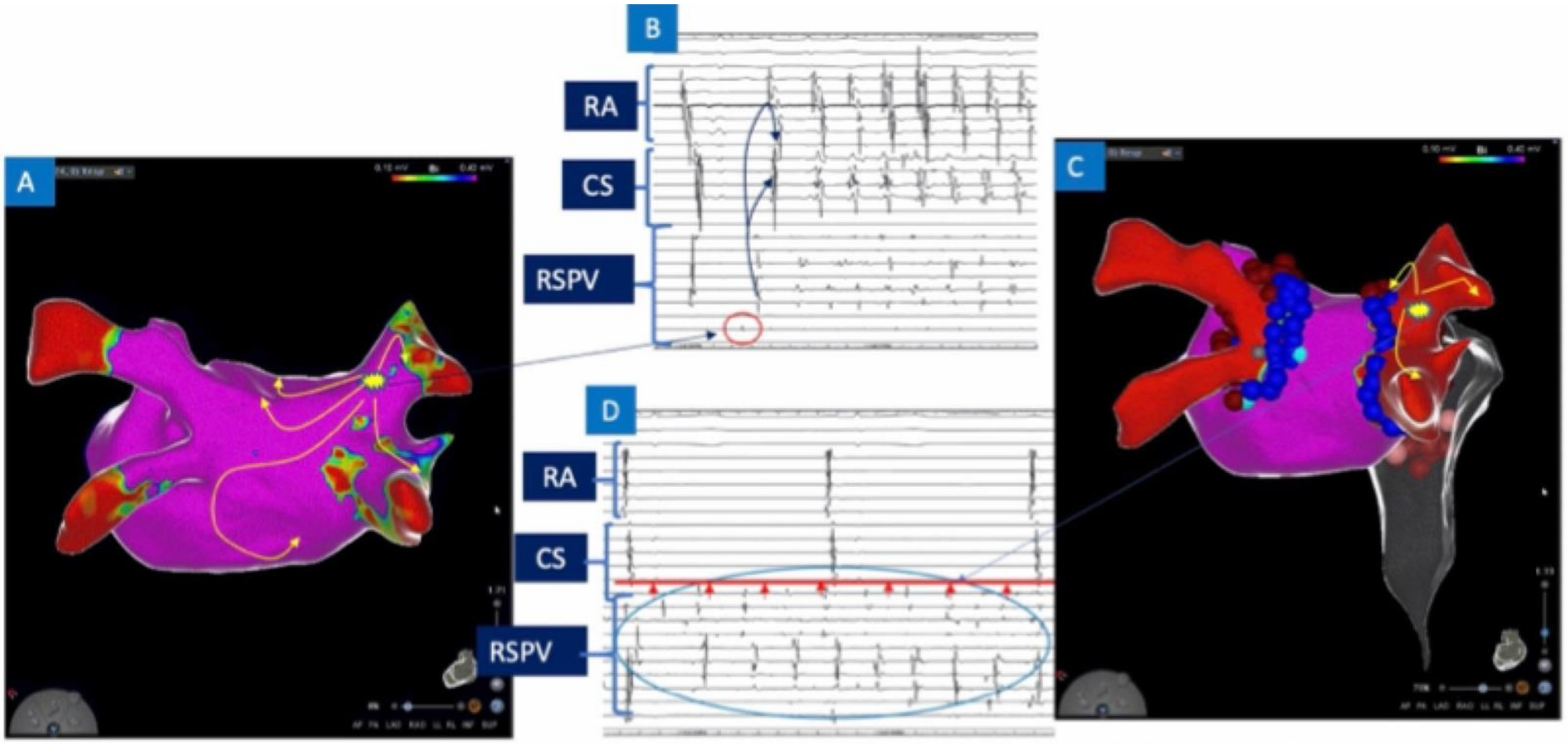
Atrial Fibrillation

- Atrial fibrillation is associated with underlying heart disease and with increased risks of death, stroke, heart failure, and dementia.
- Therapy for conditions that are associated with a risk of atrial fibrillation, including hypertension, hyperlipidemia, diabetes mellitus, sleep apnea, obesity, and excessive alcohol consumption, may reduce the risk of recurrence of atrial fibrillation.
- The presence or absence of risk factors for stroke is used to estimate the risk of stroke in order to determine whether anticoagulation is indicated for paroxysmal or persistent atrial fibrillation.
- When atrial fibrillation has been present for 48 hours or longer or for an unknown duration and elective cardioversion is planned, a period of anticoagulation before and after cardioversion is warranted, even when risk factors for stroke are absent.
- Uncontrolled tachycardia can lead to deterioration of left ventricular function. Attempts to maintain sinus rhythm should be considered when atrial fibrillation has not been persistent for more than 1 year or is paroxysmal and symptomatic. Catheter ablation is more effective than antiarrhythmic drug therapy, particularly for paroxysmal atrial fibrillation.

Atrial fibrillation is associated with an increased incidence of stroke (by a factor of approximately 4.0 in men and 5.7 in women), heart failure (by a factor of 3.0 in men and 11.0 in women), and dementia that is probably related to strokes and cerebral hypoperfusion (by a factor of 1.4 in a mixed population).[3,4,6,7] Atrial fibrillation increases the risk of death by a factor of 2.4 among men and by a factor of 3.5 among women.[8] In part, this increase reflects the fact that atrial fibrillation is often a marker for underlying heart and vascular disease. However, atrial fibrillation itself probably contributes to adverse outcomes by increasing the risk of stroke, diminishing cardiac performance, and exposing symptomatic patients to therapies that also have risks.


Mechanisms for Initiation and Persistence of AF
Atrial Anatomy
Atrial Substrate (muscle bundle)
Clinical Profiles
Triggering ectopic foci, often along the pulmonary veins
Triggers, atrial electrical remodeling, and fibrosis
Extensive atrial fibrosis and electrical remodeling, with or without triggers
Paroxysmal AF
Starts and stops spontaneously
Persistent AF
Cardioversion for interruption usually needed
Long-standing Persistent AF
Sinus rhythm not maintained

More than two thirds of patients with recently discovered atrial fibrillation have a paroxysmal pattern, but 5 to 10% per year have progression to persistent atrial fibrillation. Among patients who present with persistent atrial fibrillation and successfully undergo cardioversion, up to 20% have recurrent atrial fibrillation such that it becomes difficult to maintain sinus rhythm.[4,12,13]


A
B
RA
CS
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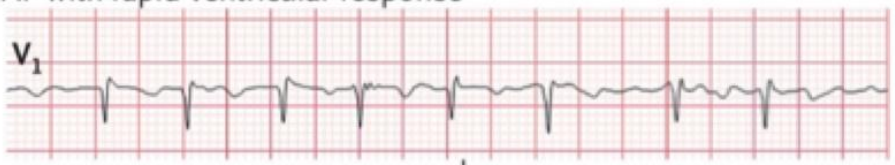
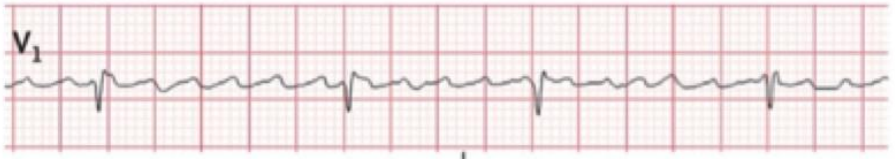
and palpitations. Rapid heart rates may cause hypotension, syncope, angina, or pulmonary edema, and emergency treatment may be warranted. Severe manifestations are often associated with acute illness or surgery that leads to increased sympathetic tone and a rapid ventricular rate.[5] Atrial fibrillation can cause a depressed left ventricular ejection fraction that improves or completely reverses after adequate rate control or restoration of sinus rhythm.[14] Although this atrial fibrillation–induced cardiomyopathy usually occurs when the ventricular rate is persistently faster than 110 beats per minute, it may occur at slower rates in some patients.[15]

A ECG Tracings

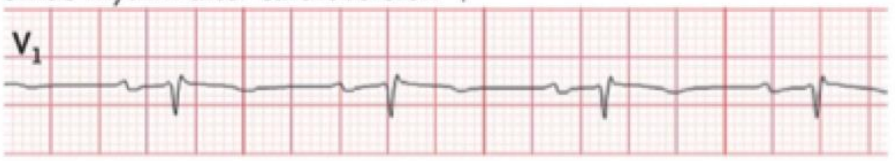
AF with rapid ventricular response



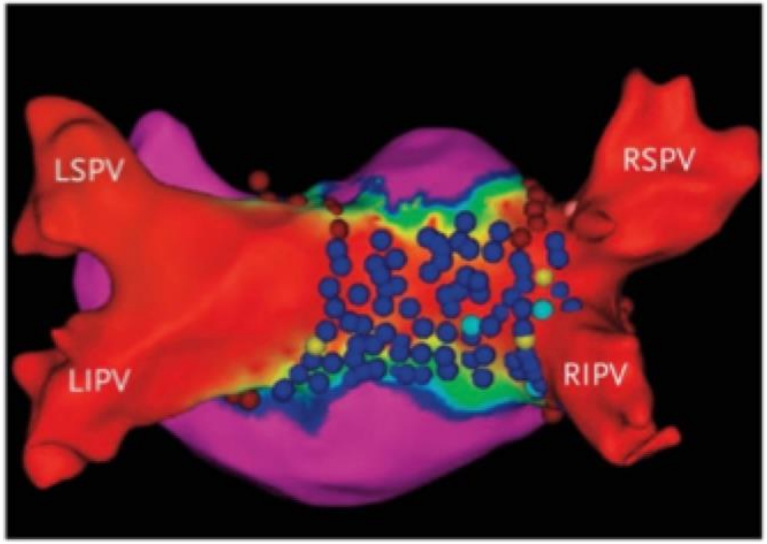
Rate-controlled AF



Sinus rhythm after cardioversion



B Atrial Electroanatomical Map



C Considerations in Management of AF

Rate Control during AF
- Beta-blockers
- Verapamil, diltiazem
- Digoxin
- AV junction ablation plus pacemaker (in selected patients)

→

Stroke Prevention
- Anticoagulation
- Occlusion or resection of atrial appendage (in selected patients)

→

Treatment of Risk Factors for AF
- Hypertension
- Hyperlipidemia
- Diabetes mellitus
- Obesity
- Sleep apnea
- Excessive alcohol use

→

Long-Term Strategy for Reducing Symptoms

Maintain Sinus Rhythm
- Antiarrhythmic medications
- Catheter ablation
- Surgical maze

or

Manage Continued AF

predisposing diseases and risk factors and intercurrent illness. Long-term alcohol consumption of more than one drink per day in women and two drinks per day in men has been associated with atrial fibrillation, and binge drinking can precipitate atrial fibrillation.[17,18] Caffeine consumption has not been shown to increase the incidence of atrial fibrillation.[17] The patient's blood glucose and thyrotropin levels should be measured.

In addition to the ECG and other cardiac monitoring when needed, transthoracic echocardiography is routinely recommended. Screening for sleep-disordered breathing should be performed, and a sleep study should be conducted when the patient's history is suggestive of sleep apnea.[17]

Rate Control

The ventricular rate in atrial fibrillation is an important determinant of hemodynamic consequences and symptoms. Atrioventricular nodal-blocking agents are usually warranted to reduce the ventricular rate. Beta-blockers and nondihydropyridine calcium-channel blockers (verapamil and diltiazem) are first-line therapies.[2] Therapy is tailored to the individual patient and is based on consideration of adverse effects (e.g., beta-adrenergic blockers may aggravate depression, and calcium-channel blockers may aggravate heart failure). Therapy is generally initiated with a beta-blocker at a dose that is adjusted upward, with the aim of controlling symptoms by reducing the heart rate. Although some physicians aim for an average resting heart rate of less than 80 beats per minute, a faster resting rate is acceptable when it is not associated with symptoms, provided that ventricular function remains normal.[20] Calcium-channel blockers may be combined with beta-blockers if the beta-blocker alone is not sufficient, but hypotension can complicate this approach, particularly in older adults. Digoxin slows the resting ventricular rate, but rate control is not usually adequate during exertion. Digoxin has been associated with increased mortality in post hoc analyses of trials involving patients with atrial fibrillation.[2,21,22] A low dose of digoxin may be added to other atrioventricular nodal agents to improve rate control, particularly in patients with heart failure.[2] In patients with exertional symptoms, it is important to assess the heart rate response to exertion (e.g., after a brisk walk in the office or with ambulatory monitoring) and to adjust the dose of therapy accordingly.