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Review

Narrative Review on Atrial Fibrillation

D.M. Chaudhary[1]*, V.K. Goyal[2] and S.K. Verma[3]

[1]Post Graduate Resident, [2]Professor & Head, [3]Professor Emeritus
Department of Medicine, Pacific Medical College and Hospital, Udaipur, Rajasthan, Bharat

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***Corresponding Author Email:** dhruvmohan01@gmail.com

ABSTRACT

Atrial fibrillation (AF) is the commonest sustained cardiac rhythm disorder. It can be caused by a variety of disorders ranging from infection in the body to cardiac structural abnormalities. Around 1% of the global population is affected by this rhythm disorder and the prevalence is increasing significantly with advancement of age of population. The diagnosis rests on classical electrocardiographic features. The treatment is complex and multifaceted. It is essentially based on restoring normal rhythm when feasible, improving symptoms, managing hemodynamic abnormalities and treating the risk of thrombo-embolism. The present review focuses on historical aspect, its etiology and risk factors, pathophysiology and diagnosis with passing remarks on its management.

KEYWORDS: Irregularly irregular pulse, Apex-pulse deficit, Atrial arrhythmia, Concealed conduction

INTRODUCTION

Atrial fibrillation (AF), is an abnormal heart rhythm and the commonest sustained disorder of cardiac rhythm, characterized by rapid and irregular contractions of atrias. It was first identified in 1909[1] and has achieved increasing importance with the increasing population of elderly individuals. Braunwald, in his Shattuck lecture[2], referred to the growing "epidemic" of AF. The impact of AF on mortality and morbidity is substantial, also it adversely affects socioeconomically in relationship to hospital admissions, chronic disease management and disabilities.

The prevalence of AF in the adult population doubles with each advancing decade of age, from 0.5% at age 50-59 years to 9% at age 80-89 years[4]. It is one of the most common complications of rheumatic heart disease. Previously, AF was thought to be one of the pathognomic signs of mitral stenosis[5].

The majority of the studies carried out in Western countries did not report rheumatic heart disease (RHD) as commonly being associated with AF[4,5,6]. In the developed world, the most common clinical diagnosis associated with permanent AF are hypertension and coronary artery disease[5]. In India, the prevalence of RHD is high. In a study conducted among this population, RHD was observed in 58% of the cases of AF[7].

A totally new approach to therapy in the form of antiarrhythmics and anticoagulation is also emerging. Ablation or modification of atrioventricular conduction with adaptive rate pacing now permits effective rate control

in virtually any patient. Judicious application of Atrial pacing may delay or prevent Atrial fibrillation. The use of improved defibrillation techniques will allow more effective management of episodes of Atrial Fibrillation and will supplement other approaches that can't be expected to be completely effective.

HISTORIOCAL ASPRCTS OF ATRIAL FIBRILLATION[8]

Pre-electrocardiographic Era

The abnormal chaotic rhythm of arterial pulse was observed by most of physicians of China, Egypt and Greece. Perhaps the earliest description of AF has been documented in the Chinese text by Huangh Ti Nei Ching Su Wen in his book The Yellow Emperor`s Classic of Internal Medicine (1696-2598 BC). William Harvey was probably the to describe "fibrillation of the auricles" in animals in the year 1628.

Robert Adams reported the association of irregular pulse in mitral stenosis in 1827. Probably he was the first to recognize the condition clinically, but as a 'sign of mitral stenosis'

In 1839, Hope identified irregular pulse in association with mitral stenosis and observed that exercise worsened the total irregularity, whereas it abolished an intermittent pulse. In 1863, a pulse tracing from a patient of mitral stenosis with irregular pulse was published by Etienna Marry. Engelman, in 1894 reported that atrial fibrillation caused by multiple foci in the atria.

Post- electrocardiographic Era

William Einthoven (1900) invented the first electrocardiographic machine to record human cardiac rhythm. A close friend of him, Sir Thomas Lewis (1909), was the first to recorded atrial fibrillation with electrocardiograph, and studied its mechanism.

Rothenberger and Winterberg, (1909) identified 'arrhythmia perpetua' and fibrillation of the auricles.

In 1935, Bouilland observed that digitalis can reduced the ventricular rate dramatically even though irregularity of pulse persists. It was Lown who recommended cardio-version of AF as apart of treatment. Bootsma and coworkers (1970) concluded after studying with computer that the irregular response of the ventricles was due to the effect of "randomly spaced atrial impulses of random strength reaching the A-V node from random directions."

In 1982, the Framingham Study, conducted by William Kennel and colleagues demonstrated epidemiological importance of AF as an important precursor of cardiac and cerebrovascular deaths.

EPIDEMIOLOGY[9]

AF is the most common arrhythmia worldwide affecting about 1.1 percent of the global population. Its prevalence is increasing with age-ranging from 7%-9% in people over 70 to 10% in those over 80. It is anticipated that the trend will get double in the next 25 years.

AF is associated with heart failure, an increased long-term risk of stroke which cause mortality more common in women. Stroke is the most devastating complication that occurs due to AF. AF leads to an increase in the risk of stroke by 5-7 % per year, although strokes occurring in AF have a much more increased morbidity and mortality both during the acute stage and in the first year as well.

Looking at the Indian perspective, a great scarcity of epidemiological data is found on AF. Therefore, if we extrapolate the United States and global data to demographics in India (2011 census), with a population of 1.3 billion, of which 8% were over 60 years of age, it is estimated that the prevalence of AF is 4-5 million cases, which leads to 2.5 lakh strokes/year. There are almost 300 million people having the age of 40 and above in India, which suggests a risk of developing atrial fibrillation in 75 million Indians in their lifetime and a massive 3.75 million people being at risk for AF related stroke.

A study conducted by the Indian Heart Rhythm Society across 24 centers during the period of July 2011 to August 2012 revealed that 47.8% cases of AF were found due to Rheumatic Heart Disease in India, making it the major underlying cause for AF in India. Applying these findings to the extrapolated population data above, the figures lead to increase by a factor of 1.5 to 2, thus making evident the grave burden of Atrial Fibrillation and morbidity and mortality in association with AF in India. Hypertension (31%), Coronary Artery Disease (27%), Heart Failure (18%) and Diabetes Mellitus (16%) are also other major causes of AF.

DEFINITION OF AF[10]

- Atrial fibrillation (AF) is a supraventricular arrhythmia that is characterized electrocardiographically by low-amplitude baseline oscillations (fibrillatory or f waves) with the ventricular rhythm being an irregularly irregula.
- The f waves with a rate of 300 to 600 beats/min and have a variability in the amplitude, timing and shape.
- During AF in the absence of any negative dromotropic agents, ventricular rate is 100 to 160 beats/min.

Atrial Flutter

Atrial flutter is a type of supraventricular tachycardia that is caused by a re-entry circuit within the right atrium. Corresponding to the size of the right atrium, the length of the re-entry circuit is defined, making it a fairly predictable atrial rate of approximately 300 bpm (range 200-400).

ECG Features of Atrial Flutter[11]

General Features

- Narrow complex tachycardia
- Regular atrial activity at ~300 bpm
- Flutter waves having a "saw-tooth" pattern are best seen in leads II, III, and a VF — may be more easily spotted by just turning the ECG upside down!
- Flutter waves in the lead V1 may resemble P waves
- Loss of the isoelectric baseline is noted.

In the V1 lead, sometimes, f waves appear uniform and also it can mimic flutter waves.

Although, **"Permanent AF"** is not really permanent as by surgical or catheterablation it may be successfully eliminated.

- **Lone AF** - AF that occurs in patients aged 60 years or below who do not have hypertension or any other evidence suggestive of any structural heart disease. *Clinical relevance*: Patients with lone AF are shown to have a lower risk of thromboembolic complications, thus eliminating the need for anticoagulation using warfarin. In addition to this, due to the absence of any structural heart disease, the safe use of Antiarrhythmic drugs can be done.
- **Silent AF** (asymptomatic) is the one manifestation of AF. It can be detected with the onset of complications

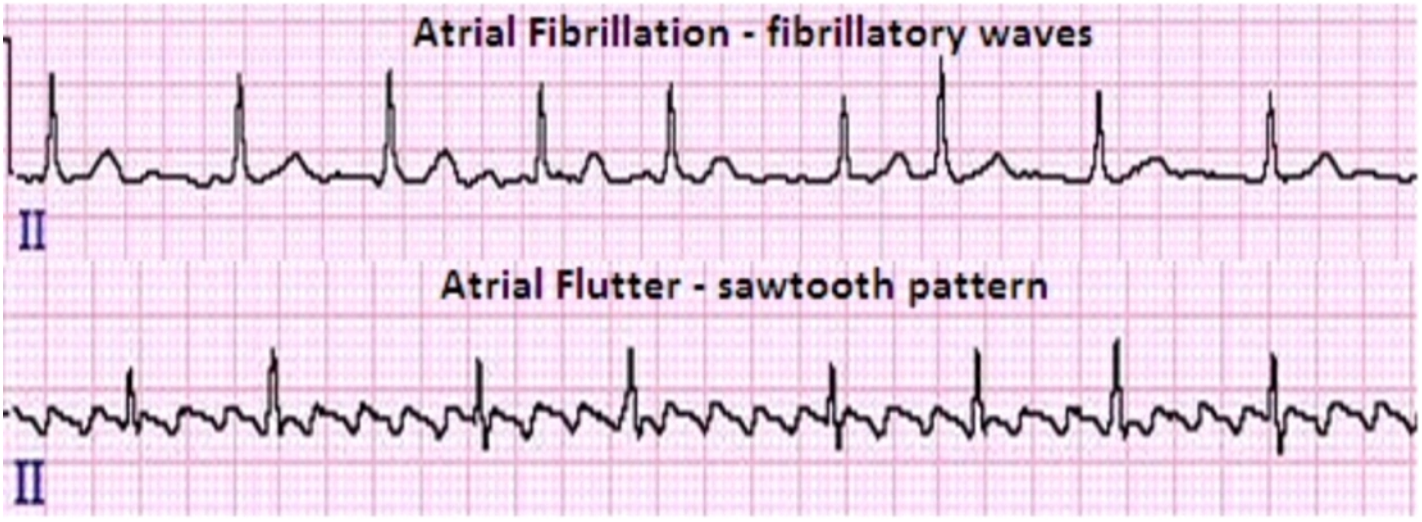

Figure 1: Atrial Fibrillation and Atrial Flutter

Comparing the f waves of AF (seen in top panel) and the flutter waves observed in atrial flutter (seen in bottom panel).

It is being noted, that f waves have variability in rate, amplitude and shape, while flutter waves are being constant in rate as well as all other aspects of morphological parameters.

CLASSIFICATION of Atrial Fibrillation[10]

- **Paroxysmal AF** - AF that terminates spontaneously between 7 days.
- **Persistent AF** - AF which presents continuously for greater than 7 days.
- **Longstanding AF** - AF that is persistent for more than 1 year.
- **Permanent AF** - Longstanding AF that is refractory to cardioversion can be termed as permanent**.**

like tachycardic-myopathy, or ischemic stroke, or it can be diagnosed as an incidental finding in ECG.

Specific Patterns of AF[9]

Three specific although relatively uncommon clinical presentations of AF are:

1. **Tachycardia- induced Tachycardia:**

   There is degeneration of one tachycardia into another. For e.g., Atrial flutter and certain atrial tachycardias degenerate into AF[12]. Regular supraventricular tachycardia like atrioventricular nodal re-entrant tachycardia can also sometimes degenerate into AF. Similarly, patients with WPW syndrome or concealed accessory pathways have a higher incidence of AF. The rate of tachycardia, accessory pathway electrophysiological properties, intrinsic atrial

vulnerability and contraction excitation feedback may be some proposed mechanisms of predisposition to AF.

2. **AF in WPW Syndrome:**

Atrio ventricular re-entry can initiate AF, which can lead to disastrous consequences if the patient is capable of sustaining a very rapid pre-excited ventricular response with conduction over the accessory pathway. The rapid heart rate can produce syncope or more importantly, AF may degenerate into ventricular fibrillation and result in sudden cardiac death[16]. These patients require radiofrequency catheter ablation of the accessory pathway to reduce or eliminate their risk of sudden death.

3. **Neurogenic AF:**

Coumel[13] described a vagal dependent atrial fibrillation and adrenergic form of AF.

- *Vagal origin AF* is characterized by:
  a) Predominantly in men rather than in women (approximately 4:1)
  b) Age of onset approximately 40 to 50 years
  c) Lone AF with minimal tendency to permanent AF
  d) Occurs at night, during rest, after eating or with consumption of alcohol
  e) AF usually preceded by progressive bradycardia

  Importantly both beta-adrenergic blocking drugs and digitalis may increase the frequency of AF.
- *Aadrenergic AF* has the following features[13]:
  1) Occurs less frequently than vagal AF
  2) Onset is exclusive during day time
  3) Often preceded by exercise and emotional stress
  4) Polyuria is common
  5) Onset typically occurs with a specific sinus rate, often near 90 beats/ minute

  In contrast to vagally induced AF, beta-adrenergic blockers are usually effective in preventing the recurrence of AF.

ETIOLOGY[14]

Loss of atrial muscle mass along with atrial fibrosis is the most frequent change in AF. Regarding fibrillation, it is assumed that it may be caused by multiple wandering wavelets, that are usually originating from the pulmonary veins. Both the mechanisms re-entrant and focal mechanisms have been proposed for the same.

Atrial fibrillation is usually related to different forms of cardio-vascular diseases but it may occur in otherwise normal heart.

- **Vascular causes** include hypertensive heart disease
- **Valvular Heart Disease,** Mitral stenosis, Mitral regurgitation, Mitral valve prolapse
- **Congenital Heart Diseases –** People with congenital heart disease tend to develop AF at a younger age, and is more likely to be of right atrial origin than of left atrial origin. They have a greater risk of progressing to permanent AF
- **Pulmonary causes** are Pulmonary embolism, obstructive sleep apnoea, chronic obstructive pulmonary disease, and carbon monoxide poisoning, pneumonia, lung cancer and sarcoidosis
- **Structural Cardiac Disease** includes hypertrophic cardiomyopathy, myocardial infarction, congestive heart failure, coronary artery disease, and any congenital heart disease, especially the ones that lead to atrial enlargement for ex. atrial septal defect
- **Pericarditis and Myocarditis**. Pericardial diseases include acute pericarditis, chronic constrictive pericarditis and pericardial effusion
- **Arrhythmias** such as Atrial tachycardias and atrial flutters are found to be associated with atrial fibrillation, as seen in Wolff-Parkinson-White syndrome
- **Endocrine causes** include Thyrotoxicosis, pheochromocytoma, hyperthyroidism or subclinical hyperthyroidism, hypothyroidism and obesity
- **Surgery** of both types including cardiac and noncardiac can result in AF
- **Electrolytes' disturbances** such as Hypokalemia and Hypomagnesaemia
- **Systemic stress** factors like fever, hypoxia, anemia, sepsis, and infections such as pneumonia
- **Medications or toxins** like Digitalis, adenosine, amphetamines, theophylline, cocaine, antihistamines, steroidal anti-inflammatory drugs (SAIDs), alcohol abuse ("holiday heart syndrome") and/or alcohol withdrawal, caffeine, nicotine, nonsteroidal anti-inflammatory drugs (NSAIDs)
- **Frequency of vigorous exercise** routine is also found to be associated with higher risk of developing AF especially in young men and regular joggers
- **Porphyrias** are also been found to be associated with autonomic dysfunction and a higher risk of AF
- **Other conditions**- Patients having metabolic syndrome, excessive intake of vitamin D, or excessive intake of niacin are found to have an increased risk of AF

Risk Factors for Atrial Fibrillation

- ***Non-modifiable factors*:** Genetics, Age, Gender, Ethnicity
- ***Modifiable factors***: Sedentary lifestyle, Tobacco use, High blood pressure, Obesity, Diabetes, Obstructive sleep apnea

Outcomes of AF

- Stroke
- Myocardial Infarction
- Heart Failure
- Systemic Embolisation
- Venous
- Thrombo-embolic Disease
- Dementia

Pathophysiology

In AF the pathophysiology there is an important role of "atrial remodeling". Atrial remodeling constitutes of any persistent change in atrial function or structure. Atrial structural remodeling: It is found that many conditions, are associated with LA remodeling and dilatation. In response to two broad conditions the atria may enlarge: pressure overload and volume overload.

Subjects with[15,16] and without[17,18] mitral valve disease are found to have a relationship between increased filling pressure and an increase in LA size that is found to be validated against invasive measures. Left atrial enlargement due to pressure overload that is usually secondary to that of increased LA afterload, in the conditions of mitral valve disease or LV dysfunction. Case reports are suggestive of that LA dilatation may also occur due to pressure overload that is the result of fibrosis and/or the calcification process of the LA. The described condition is known as "*stiff LA syndrome*"[19], which causes a decrease in LA compliance, a makeable increase in LA and the pulmonary pressures, and in the conditions of right heart failure. Chronic volume overload is found to be associated with conditions such as arteriovenous fistulas, valvular regurgitation, and various high output states that include chronic anemic state and athletic heart, which can also be the contributing factor in generalized chamber enlargement. Both volume overload and pressure overload can lead to an increase in atrial size. Although, pressure overload is found to be uniformly accompanied by abnormal myocyte relaxation, while volume overload is characteristically related to normal physiological myocardial relaxation.

A variety of Electrophysiological and Structural Factors promote the perpetuation of AF.

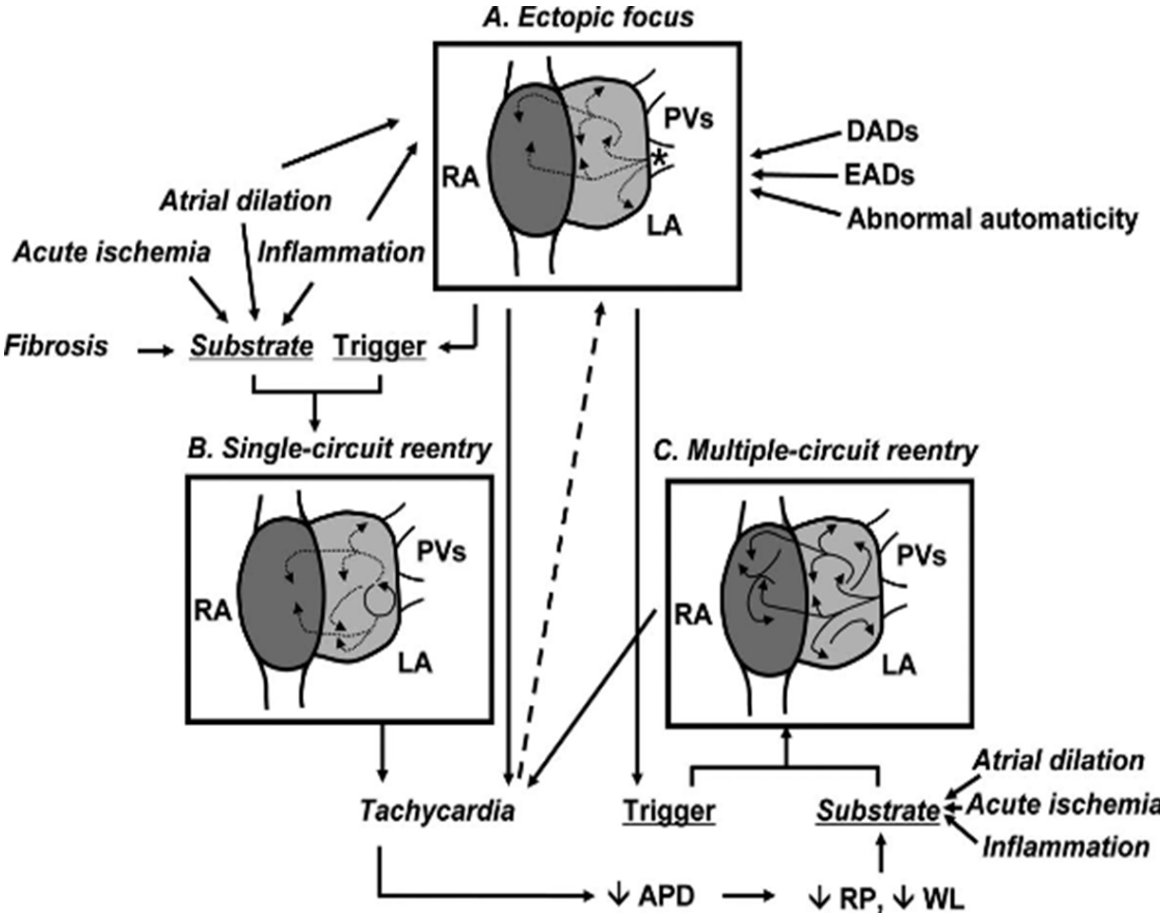

Figure 2: Principal Mechanisms that can Produce AF

Re-entry involves a vulnerable substrate, which requires a trigger for re-entry initiation. Ischemia, inflammation, and dilation make atria more vulnerable to AF. AF that results from any mechanism causes tachycardia-induced remodeling. Even if AF is initially maintained by ectopic activity or single-circuit re-entry in a given patient, ATR-induced spatially heterogeneous refractoriness abbreviation creates conditions favorable to multiple-circuit re-entry, which may then become the AF-maintaining mechanism. Thus, multiple circuit re-entry may be a final common pathway AF mechanism in many patients.

RA indicates right atrium; PVs, pulmonary veins; LA, left atrium; RP, refractory period; and WL, wavelength.

Moe and colleagues[20] proposed the multiple wavelet hypotheses as the mechanism of AF. Fractionation of wavefronts traversing the atria into daughter wavelets has been proposed as the mechanism by which this non-repeating arrhythmia perpetuates.

Li and colleagues demonstrated in a canine model of heart failure that interstitial fibrosis predisposed to intra-atrial re-entry and AF[21].

Fibrosis of the atria may produce in homogeneity of conduction within the atria, leading to conduction block and intra atrial re-entry. A variety of clinical studies have demonstrated that patients with AF have delayed interatrial conduction and inhomogeneous dispersion of atrial refractory periods[22].

Long-standing AF results in loss of myofibrils, accumulation of glycogen granules, and disruption in cell-to-cell coupling at gap junctions and organelle aggregates[23]. ADAMs (a disintegrin and metalloproteinase), a family of membrane-bound glycoproteins that regulate cell–cell and cell–matrix interactions, have been reported to double in concentration during AF in human biopsies of atrial myocardium. This increased disintegrin and metalloproteinase activity may be one mechanism contributing to atrial dilatation in AF.

Thus, AF itself seems to produce a variety of alterations of atrial architecture that further contribute to atrial remodeling, mechanical dysfunction, and perpetuation of fibrillation Atrial refractoriness depends on cardiac action potential duration (APD), because the Na+ channels that govern cardiomyocyte excitability inactivate when cells are depolarized and require repolarization to–60 mV for channel availability to return. APD is determined by the balance between inward currents (primarily Ca2+, which tends to keep the cell depolarized) and outward currents (primarily K+, which tends to repolarize) during the action potential plateau. Atrial remodeling can abbreviate APDs and refractory periods in either way: Sustained rapid atrial activation, as occurs during AF, reduces inward L-type Ca2+ current (ICaL) and also enhances outward K+ currents. These actions are major contributors to clinically relevant AF promotion.

Atrial dilation increases the amount of atrial tissue that can accommodate re-entry circuits. Larger atrial size justifies having more circuits that can be accommodated and also that circuits having long long-wavelength are very large for the normal atrium.

Atrial dimensions are a particularly important determinant of the occurrence of multiple-circuit re-entry[24]. Atrial enlargement can occur with both atrial tachycardia – and CHF-related remodeling[24] and is an important clinical predictor of AF maintenance. However, atrial dilation is not essential for the maintenance of CHF related AF dilatation of atria is not essential. Once full hemodynamic recovery has occurred from CHF, the fibrosis remains, and this leads to inducible sustained AF, even in the absence of dilatation of atria.

COMPLICATIONS OF ATRIAL FIBRILLATION

Thromboembolic risk of systemic emboli is due to circulatory stasis in the left atrial cavity or appendage. Platelet activation in embolic and pre-embolic status of patients with non-rheumatic atrial fibrillation was studied. It was found that the number of circulating platelets expressing P selectins and CD[25] was significantly higher in the patients positive for both spontaneous echo contrast and left atrial thrombus or embolic events. Besides, in these groups, significantly more leucocyte-platelet conjugates were present[26]. Ischaemic infarction occurs when LA clot embolises to the brain.

There are no reliable clinical clues to diagnose cardiogenic stroke, but suggestive features include the existence of a potential embolic source, abrupt onset of maximal neurological deficit, multiple infarcts involving the cerebral cortex or cerebellum in several vascular territories and absence of atherosclerotic cerebrovascular disease[26]. Haemorrhagic infarcts are more likely to be embolic because bleeding may occur as embolic fragments migrate distally from the site of infarction allowing reperfusion of the infracted tissue.

Rheumatic mitral valve disease had previously been the leading cause of cardiogenic thrombi, but atrial fibrillation of any cause now accounts for about 45% of all cases and ischaemic heart disease with left ventricular thrombus accounts for an additional 25 %[27]. Hinton et al. in 1977 reported that AF is known to increase greatly the risk of systemic embolism in patients with mitral valvular disease. In the light of clinical frequency of embolism in patients with AF due to other types of heart disease, a study was made on embolic occurrence in 323 autopsy cases with atrial fibrillation. Considering only symptomatic emboli with pathological or surgical confirmation, embolism occurred in 41% of patients with mitral valve disease, 35% of those with ischaemic heart disease, 35% of those with co-existing mitral and ischaemic heart disease, 17% of those with various other types of heart disease[27].

Embolism was found in only 7% of a control group of 58 autopsy cases with ischaemic heart disease and no atrial

fibrillation. These findings suggest that there is a high risk of embolism from AF of any origin, particularly from that caused by mitral valve disease and ischaemic heart disease. Among the symptomatic embolism, the brain was involved in 73% of cases. The remaining emboli involved the mesenteric artery renal artery, coronary artery, and large arteries of limbs.

The consequences of embolic stroke are frequently devastating 50 – 70 % of such embolic strokes result in either death or severe neurological deficit.

Paroxysmal or transient AF causes a reduced annual risk of stroke than those with chronic AF[28]. The definition of lone atrial fibrillation is frequently extended to require the exclusion of diabetes, hypertension and in some series age more than 60 is also excluded. In general stroke rates are much lower in patients with lone AF.

According to Framingham data at the 30-year point of follow up, the annual risk of stroke among patients with lone AF was 2. 5% per year, considerably less than the overall stroke risk.

Cardiac Failure in AF

It may result from altered hemodynamic or cardiomyopathy. Hemodynamically loss of atrial transport reduces the resting cardiac output by 20% particularly with increasing age.

Cardiac output is further reduced by impaired diastolic filling and rapid ventricular rate and irregular rate itself. AF is also associated with cardiomyopathy in the atria and ventricle (tachycardia induced cardiomyopathy). This cardiomyopathy improves symptomatically and echocardiographically with heart rate control and after cardio version. Atrial Cardiomyopathy may also be a mechanism for AF, through which focal AF may progress to generalized atrial disease[29,30].

Cognitive defects increasingly develop in AF even in the absence of clinical stroke, and may be related to the 'silent' lacunar infarcts and atrial infracts. Besides, significant deficits in attention, memory and language have been reported among AF patients with no clinical evidence of cerebral ischemia[31].

Left Atrial Size and Atrial Fibrillation

Since rheumatic fever is the etiology of mitral valve disease some investigators have suggested that atrial fibrillation is related to rheumatic involvement of the left atrial wall, 10 others however have noted that patients with atrial fibrillation have a larger left atrium and interpreted this as atrial dilatation is some way related to atrial fibrillation[32,33]. These associations have important clinical and therapeutic implications also.

In a population-based study of elderly patients without AF at baseline, Tsang and co-workers 29 demonstrated that AF developed in direct relation to the echocardiography left atrial volume index. It has been suggested that the presence or absence of atrial fibrillation is closely related to both degrees of left atrial dilatation. This study also indicates that quantitative estimation of left atrial size by echocardiography provides a relatively numerical cut off in left atrial dimension that separates patients in normal sinus rhythm with others that have chronic or paroxysmal atrial fibrillation[13]. Thus, in their study, atrial fibrillation was rare in patients with left atrial dimension below 40 mm but common when exceeded above 40 mm. The information obtained in the study suggests that measurement of left atrial size by echocardiography allows to identify patients in high-risk group. They also found that in several patients without a history of atrial fibrillation had moderate left atrial enlargement indicating that atrial dilatation can be produced by a hemodynamic burden alone. Chronic hemodynamic burden initially produces atrial dilatation with structural damage to the atrial wall. Atrial dilatation in turn increases likely hood of development of atrial fibrillation through re-entrant mechanisms, once atrial fibrillation is present atrial dilatation could progress as a consequence of either hemodynamic burden, the loss of atrial systole or both[13].

Wilbert et al.[34] in their study of 588 elderly patients an enlarged left atrial dimension was present in 38 of 67 patients who had atrial fibrillation 57% and only 44 of 521 elderly persons 8% with sinus rhythm had enlarged left atrial dimension. It is now well recognized that AF, if persistent enough, generates molecular, cellular, and architecture alterations in the atrial myocardium, resulting in electrophysiological and then structural changes. Other modifiers that impact atrial size include the presence or absence of pressure overload resulting from systolic or diastolic left ventricular dysfunction or valvular regurgitation.

In a study**,** Ho et al.[35] compared the dimensions of the LA among patients undergoing AF ablation and controls. The longitudinal, anterior–posterior, and transverse diameters of the LA was 64.2 ± 7.8, 33.1 ± 6.3, and 56.1 ± 6.3 mm, respectively, in AF patients and 54.9 ± 5.5, 28.1 ± 3.5, and 46.5 ± 5.6 mm, respectively, in controls. Several large population-based prospective studies have shown a strong association between LA diameter and the risk of new onset AF.

In the Framingham Heart Study, every 5-mm increase in LA diameter increased the development of AF by 39%, while the Cardiovascular Health Study showed a four-fold increase in the risk of new AF with LA diameter. 0.5 mm.

Papazoglou NM[36] et al., worked on the problem of the genesis of atrial fibrillation in 3679 patients with non-ischemic heart diseases, and concluded that age factor is of primary importance for the provocation of atrial fibrillation in all sorts of non-ischemic cardiac diseases, and second important factor is the degree of hemodynamic burden at the level of the atria (especially the left).

Petersen P. et al.[37] conducted a study to determine LA dimension in patients with atrial fibrillation of short duration and of long duration. A significant difference in LA dimension was present when compared to atrial size in normal sinus rhythm (38 ±6 mm). The left atrial dimension was (43 ± 5 mm)

in patients with atrial fibrillation of longer duration i.e., more than one year. They also found a significant increase in LA dimension after 6 months of follow up in both groups, showing that atrial fibrillation contributes to the enlargement of the atria.

Brodsky MA et al.[38] studied 43 patients with chronic atrial fibrillation, to determine factors associated with the maintenance of sinus rhythm after conversion and concluded that factors positively associated with the success of conversion were, duration of chronic atrial fibrillation ≤ year, and LA dimension ≤ 60 mm ($p < 0.05$).

Sanfilippo AJ et al.[39] studied 15 patients with chronic atrial fibrillation and followed up with them for 20.6 months. A significant increase in left atrial volume (from 45.2 to 64.1 cm3, $p < 0.001$) was observed and concluded that atrial enlargement can occur as a consequence of atrial fibrillation.

Suarez GS et al.[40] studied 23 subjects of lone atrial fibrillation, and concluded that atrial fibrillation may cause a slow and progressive increase in left atrial size.

Vaziri SM et al.[41] studied an elderly, population-based sample, and concluded that left atrial enlargement, increased left ventricular wall thickness, and reduced left ventricular fractional shortening were predictive of risk for nonrheumatic atrial fibrillation.

Flaker GC et al.[42] studied 486 patients with intermittent atrial fibrillation, and found that left atrial size was a useful predictor of recurrent atrial fibrillation; the larger the left atrium, the higher the risk of development of recurrent atrial fibrillation.

Arnow WS et al.[43] in their prospective study comprising1699 elderly patients aged more than 60 years, concluded that elderly patients with atrial fibrillation had a 2.9 times higher prevalence of left atrial enlargement than elderly patients with sinus rhythm.

Rostagno C, et al.[44] in their echocardiographic follow up study of 20 patients with paroxysmal lone atrial fibrillation, concluded that in patients with lone AF, left atrial dilatation occurs only after the arrhythmia becomes chronic and early restoration of sinus rhythm may intercept the vicious circle leading to atrial enlargement.

Left Atrial Size and Atrial Fibrillation in Mitral Stenosis

The combination of mitral valve disease and atrial inflammation secondary to rheumatic carditis causes:

1) Left atrial dilation,
2) Fibrosis of the atrial wall, and
3) Disorganization of the atrial muscle bundles.

These changes lead to disparate conduction velocities and inhomogeneous refractory periods.

Premature atrial activation caused either by an automatic focus or re-entry, may stimulate the left atrium during the vulnerable period and thereby precipitate AF. The development of this arrhythmia correlates independently with the severity of the MS, the degree of left atrial dilation, and the height of the left atrial pressure with mitral valve area, atrial size and cardiac rhythm are considered together. Thus, it is apparent that valve area is not the prime determinant of left atrial size.

Fraser and Turner[45] concluded from a study of 269 patients with mitral valve disease that atrial fibrillation bears no direct relationship to the severity of mitral disease. Atrial enlargement on the other hand has been found with greater frequency in patients with atrial fibrillation than those in sinus rhythm.

In a study by George W Bailey et al., Biopsies of the posterior wall of the left atrium were obtained from 44 patients undergoing mitral surgery for mitral valvular disease, and the specimens were graded according to the severity of morphologic change. They proposed fibrosis after rheumatic inflammatory insults lead to atrial fibrillation by disturbing impulse propagation in the atrium; prolonged atrial fibrillation leads to disuse atrophy of muscle, and atrial fibrillation becomes irreversible. These pathologic changes may be used for predicting the success or failure of the cardio version and probability of maintaining sinus rhythm.

Thiedemann et al.[46] observed various myocardial derangements in the atria of patients with mitral stenosis, ranging from hypertrophy to myofibrillar lysis, atrophy and fibrosis. Atrophy of the sinoatrial node and intranodal conduction tissue has frequently been described in patients with mitral stenosis and atrial fibrillation.

Takashashi N et al.[47] studied 17 patients with rheumatic heart disease with atrial fibrillation, and concluded that the left atrium was dilated (53.3 ± 0.2 mm) compared to normal subjects (23.3 ± 0.7 mm).

Gad Keren et al.[48] studied 155 patients with mitral stenosis, and concluded that there were no significant hemodynamic differences between patients with mitral stenosis, who were in either sinus rhythm or atrial fibrillation. The left atrium was larger ($p < 0.001$) in patients with mitral stenosis and atrial fibrillation (37.6 ± 10.8 mm) than patients in with sinus rhythm (27.8 ± 7.7 mm).

Conradie C et al.[49] studied sixty-nine patients with mitral stenosis and concluded that atrial fibrillation and left atrial enlargement were risk factors for left atrial thrombi in mitral stenosis.

Fuberg CD et al.[50] studied 5,201 men and women aged ≥ 65 years, and concluded that a history of congestive heart failure, valvular heart disease and stroke; echocardiographic evidence of enlarged left atrial dimension, abnormal mitral or aortic value function and advanced age were independently associated with atrial fibrillation.

Vivek Gupta et al.[51] studied 376 patients of rheumatic mitral valve disease with the AF, to assess whether left atrial enlargement as a predictor of atrial fibrillation in rheumatic

mitral valve disease. Left atrial enlargement of more than 5 cm was found in 341 (90.7%) patients, thus indicating left atrial enlargement to be the commonest associated predictor of AF in patients with rheumatic mitral valve disease.

Moreyra AE et al.[52] from their cardiac catheterization study of 314 patients with mitral stenosis with atrial fibrillation, concluded that both severity of mitral stenosis and increased right atrial pressure were independently associated with AF.

Mrozowska E et al.[53] studied 141 patients with isolated mitral valve disease, and concluded that age, and left atrial dimension were strongly associated with atrial fibrillation was rare when the left atrial dimension was below 40 mm.

G. Singh et al.[54] studied 64 patients having AF, and found that 23 patients with RHD and atrial fibrillation have a mean LA size larger compared to those in sinus rhythm (5.02 cms V/s 4.41 cms).

Kulkarni AG et al.[55] studied 65 cases of RHD with mitral valve disease, to find out the relationship between left atrial size and the presence of atrial fibrillation. The mean LA size in patients with AF was larger compared to those in sinus rhythm (55.6 mm Vs 47.1 mm) which was statistically significant ($p < 0.001$). In patients with AF, LA size did not differ much with the severity of mitral stenosis.

CLINICAL EVALUATION

Clinical History

1) Scoring System for AF Related Symptoms:

European Heart Rhythm Association (EHRA)[56] score of AF-related symptoms should be included in the clinical evaluation of AF. Another scale is the Canadian Cardiovascular Society Severity of Atrial Fibrillation (CCS- SAF scale)[57].

The risk of stroke in patients with AF is determined by the presence of risk factors and comorbid conditions. Many scoring systems are available of which $CHADS_2$and CHA_2DS_2 -VASc Systems are the ones most commonly used clinically. These scoring systems not only indicate the estimated risk of stroke and systemic embolism in patients with AF but also guide the need for long term oral anticoagulation.

CCS SAF Score	Impact	EHRA Class	Impact
CCS SAF 0	Asymptomatic	EHRA I	No symptoms
CCS SAF 1	Minimal effect on QOL	EHRA II	Mild symptoms
CCS SAF 2	Modest effect on QOL	EHRA III	Severe symptoms; daily activity affected
CCS SAF 3	Moderate effect on QOL	EHRA IV	Disabling symptoms; Normal daily activity discontinued
CCS SAF 4	Severe effect on QOL		

Figure 3: Comparison of SAF and EHRA Class for Symptoms of AF[9]

$CHADS_2$ -> CHA_2DS_2VASc

$CHADS_2$ Risk	Score
CHF	1
Hypertension	1
Age > 75	1
Diabetes	1
Stroke or TIA	2

From ESC AF Guidelines
http://escardio.org/guidelines-surveys/esc-guidelines/GuidelinesDocuments/guidelines-afib-FT.pdf

CHA_2DS_2-VASc Risk	Score
CHF or LVEF ≤ 40%	1
Hypertension	1
Age ≥ 75	2
Diabetes	1
Stroke/TIA/ Thromboembolism	2
Vascular Disease	1
Age 65 - 74	1
Female	1

Figure 4: $CHADS_2$ and CHA_2DS_2VASc Score[9]

$CHADS_2$	STROKE or TE/100 Person Years	
	Ischemic Stroke	**Stroke/TIA/TE**
0	0.6	0.9
1	3	4.3
2	4.2	6.1
3	7.1	9.9
4	11.1	14.9
5	12.5	16.7
6	13	17.2
CHA_2DS_2-VASc		
0	0.2	0.3
1	0.6	0.9
2	2.2	2.9
3	3.2	4.6
4	4.8	6.7
5	7.2	10.0
6	9.7	13.6
7	11.2	15.7
8	10.8	15.2
9	12.23	17.4

Figure 5: Stroke or Thromboembolism (TE)/ 100 years at Risk in Relation to $CHADS_2$ AND CHA_2DS_2 - VASc Score[58]

	Clinical Characteristic	Points
H		1
A	Abnormal Renal or liver functions(1 point each)	1 or 2
S	Stroke	1
B	Bleeding	1
L	Labile INRs	1
E	Elderly (e.g., age >65 years)	1
D	Drugs or alcohol(1 point each)	1 or 2
		Maximum 9 points

Figure 6: Clinical Characteristics Comprising HAS-BLED Bleeding Risk Score

Both CHA_2DS_2-VASc and HAS-BLED score has many modifiable risk factors. Attempts should be made to minimize both ischemic and bleeding risk by tackling these risk factors

Associated Risk Factors and Diseases with AF

Age is found to be considered an independent risk factor. With the addition of each decade, the risk of AF nearly doubles both in men and women[59,60].

Factors such as valvular heart disease, hypertension, CHF and Myocardial Infarction are cardiovascular risk factors.

A systolic BP > 150 mm hg has been shown to be a statistically significant risk factor for AF[61]. A widened pulse pressure is also a risk factor for AF.

Both heart failure and AF have common risk factors and each one predisposes to the other. Symptomatic Heart failure is found in 30% of patients with AF. There is an increased frequency of AF in Acute Coronary Syndrome. During Acute MI the incidence of AF is between 6% to 21%[62].

Valvular Heart disease especially Mitral Stenosis and Mitral regurgitation are independent risk factors for AF. One observation study found that by the time of clinical presentation, 20% of patients with mitral stenosis had already developed AF and 33% had developed AF by the end of 10 years follow up period[63]. AF can occur in the later stage of aortic valve disease as well.

AF is well established manifestation of hyperthyroidism. In the Canadian registry for AF and Danish National Registry, overt hyperthyroidism was observed in 1% and 8.3% of patients with AF respectively[64]. Even the patients with subclinical hyperthyroidism and with TSH in low normal range are observed to be at increased risk for AF[65].

Diabetes, Obesity and metabolic syndrome are also the independent risk factors for AF[66]. Obstructive Sleep Apnoea is also an independent risk factor for AF in patients younger than 65 years[67].

Modifiable risk factors like smoking (resulting into COPD) and heavy ethanol intake also predispose to AF[68,69].

Cardiomyopathies including primary electrical cardiac disease[70] carry an increased risk of AF, especially in young patients. It is reported that a small proportion of patients having "Lone AF" may carry any known mutations responsible for electrical cardiomyopathies.

Genetical Predisposition

AF has a familial component especially AF of Early onset[71]. Both short and long QT syndromes and Bragada syndrome are associated with supraventricular arrhythmias including AF[72]. AF also frequently occurs in a variety of inherited conditions including hypertrophic cardiomyopathy, a familial form of ventricular pre-excitation and abnormal LV hypertrophy associated with mutation in PRKAG gene. Other familial forms of AF are associated with mutation in gene coding for atrial natriuretic peptide[73]. Loss of function or mutation in the cardiac sodium channel gene SCN5A[74], or gain of function in cardiac potassium channel.

Medications

Various medications are found to incite AF/ The mechanisms for drug induced AF may include:

1) Adrenergic or vagal stimulation
2) Modified atrial conduction
3) Refractoriness or automaticity
4) Direct cardiotoxicity
5) Electrolyte disturbances
6) Coronary vasoconstriction

Adenosine is commonly used to terminate paroxysmal supraventricular tachycardia, however, it can induce AF in up to 10% of patients.

Other medications that can incite AF include Dopamine, Dobutamine, Milrinone, anticholinergics and thiazides. Toxic level of Digoxin may lead to the development of Atrial Tachycardia or even AF.

Although a drug may not necessarily AF it may potentiate its occurrence in the settings of established electrophysiological substrate for AF.

Dyspnoea:

- Dyspnoea is initially exertional, but gradually progresses to a state of breathlessness even at rest.
- Dyspnoea results from pulmonary venous congestion occurring as a result of pulmonary venous hypertension.
- Severe exertion, excitement, fever, anemia, pregnancy, thyrotoxicosis and atrial fibrillation can all aggravate / precipitate dyspnoea.

Orthopnoea and Paroxysmal Nocturnal Dyspnoea:

In the supine position, there is increased venous return to the heart, which will increase pulmonary venous pressure, resulting in orthopnoea and paroxysmal nocturnal dyspnoea.

Pulmonary Edema:

Pulmonary Edema develops when pulmonary capillary pressure exceeds 25mmHg and the resulting transudate cannot be cleared by lymphatics. It may occur suddenly, as a presenting feature of mitral stenosis or it may develop gradually preceded by orthopnoea and paroxysmal nocturnal dyspnoea.

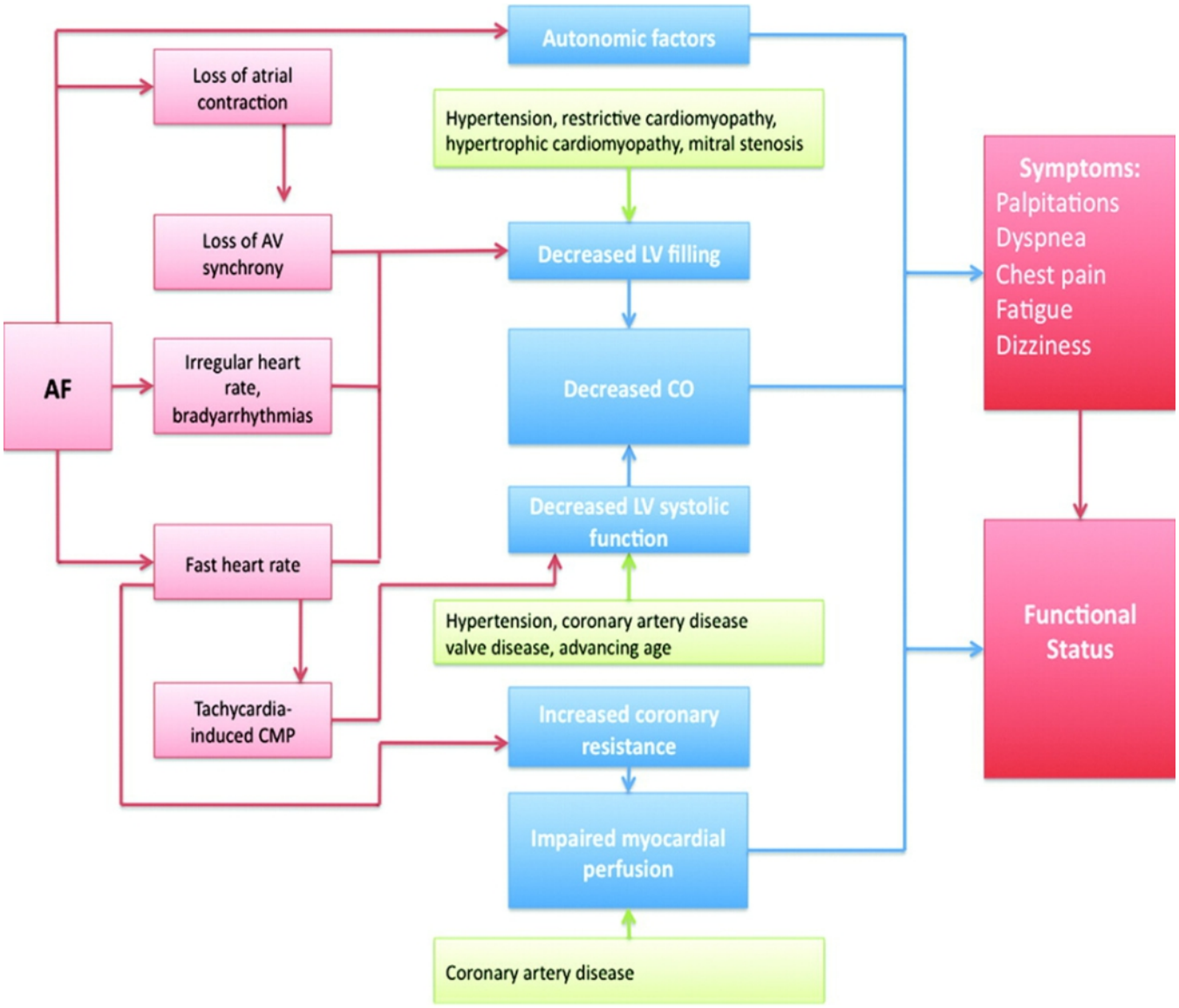

Figure 7: Conceptual Model of Pathophysiological Mechanisms relating Atrial Fibrillation (AF) and Symptoms. *CO indicates Cardiac Output*[9]

Haemoptysis:

Wood has differentiated between several kinds of hemoptysis complicating mitral stenosis:

1) Sudden hemorrhage due to rupture of a thin-walled dilated bronchial veins as a consequence of a sudden rise in left atrial pressure.
2) Blood-stained sputum associated with attacks of PND.
3) Pink frothy sputum of acute pulmonary Edema with rupture of alveolar capillaries.
4) Pulmonary infarction due to pulmonary embolism.
5) Blood-stained sputum complicating chronic bronchitis.

Palpitations:

Palpitation may be due to compensatory sinus tachycardia caused by low cardiac output or fast ventricular response in atrial fibrillation. Palpitations may be paroxysmal or persistent.

Chest Pain:

This may be due to severe pulmonary hypertension, coincidental coronary atherosclerosis, coronary embolism, pulmonary infarction with pleuritic chest pain.

Thromboembolism:

These are common in older people, who have developed atrial fibrillation, low cardiac output and dilatation of the left atrial appendage are at the highest risk.

Others:

- Hoarseness of voice due to compression of left recurrent laryngeal nerve by dilated left atrium (Ortner's syndrome).
- Dysphagia caused by left atrium compressing esophagus.
- Loss of appetite and upper abdominal discomfort occurs due to congestion of gastrointestinal tract and liver.
- Symptoms of right heart failure like peripheral Edema, right hypochondrial pain etc.

PHYSICAL SIGNS

General Examination:

- Peripheral and facial cyanosis occurs in extremely severe cases.
- Mitral facies characterized by malar flush (pinkish - purple patches on the cheeks) is uncommon and is caused by peripheral cyanosis, which is usually associated with a low cardiac output, systemic vasoconstriction and severe pulmonary artery hypertension.
- Peripheral Edema in congestive heart failure.

Pulse:

- Irregularly irregular rhythm and varying volume in atrial fibrillation.

Apex Beat Deficit:

The difference in ventricular rate and peripheral pulse rate is called as an apex pulse deficit. In atrial fibrillation with a fast ventricular rate, each ventricular contraction is not strong enough to cause peripheral pulse hence apex pulse deficit is felt. But in cases of atrial fibrillation with slow ventricular rate especially when patients are on positive inotropic like digoxin each ventricular contraction will cause peripheral pulse hence apex pulse deficit may not be apparent.

Blood Pressure:

Blood pressure is normal or slightly reduced and vary beat to beat.

Jugular Venous Pulse:

" waves of jugular venous pulse are absent.

Inspection and Palpation:

- Precordial bulge in chronic cases with onset of illness early in life.
- Apex beat is normal in position in isolated MS, whereas it may be shifted with the development of right ventricular hypertrophy.
- Diastolic thrill at the apex, which is best, felt with the patient in left lateral position, with breath held in expiration.
- Visible and palpable pulsations in the second left intercostal space, from the underlying dilated pulmonary artery in pulmonary hypertension.
- Palpable P2 in the pulmonary area due to pulmonary hypertension.
- Visible and palpable left parasternal heave and epigastric pulsation due to right ventricular hypertrophy.

Auscultation:

Heart Sounds

- Loud S1with varying loudness is an important finding of AF in MS.
- In associated atrial fibrillation, the first heart sound vares in intensity.
- Loud second heart sound is an important sign of pulmonary hypertension.

Other Findings:

- Tender hepatomegaly, peripheral Edema, ascites may occur with severe right ventricular failure.

Investigations

An initial diagnostic workup of suspected or documented AF includes an electrocardiogram (ECG) and transthoracic Echocardiography.

Any arrhythmia that has ECG characteristic of AF and lasts for sufficiently long for a 12 lead ECG to be recorded for at least 30 seconds, on a rhythm strip, should be considered as AF. ECG also provides evidence of chamber enlargement, hypertrophy or previous MI and establishes a baseline corrected QT interval

for guiding the use of anti-arrhythmic medications that can produce QT interval prolongation.

Electrocardiography:

ECG Features of Atrial Fibrillation [Figure 8]

- Irregularly irregular rhythm.
- No P waves.
- Absence of an isoelectric baseline.
- Variable ventricular rate.
- QRS complexes usually < 120 m unless pre-existing bundle branch block, accessory pathway, or rate related aberrant conduction.
- Fibrillatory waves may be present and can be either fine (amplitude < 0.5mm) or coarse (amplitude >0.5mm).
- Fibrillatory waves may mimic P waves leading to misdiagnosis.

Other Features:

- *Ashman Phenomenon* – aberrant ventricular conducted beats, usually of RBBB morphology, secondary to a long refractory period as determined by the preceding R-R interval.
- The ventricular response and thus ventricular rate in AF is dependent on several factors including vagal tone, other pacemaker foci, AV node function, refractory period, and medications.
- Commonly AF is associated with a ventricular rate ~ 110 – 160.
- AF is often described as having 'rapid ventricular response' once the ventricular rate is > 100 bpm. [Figure 9].

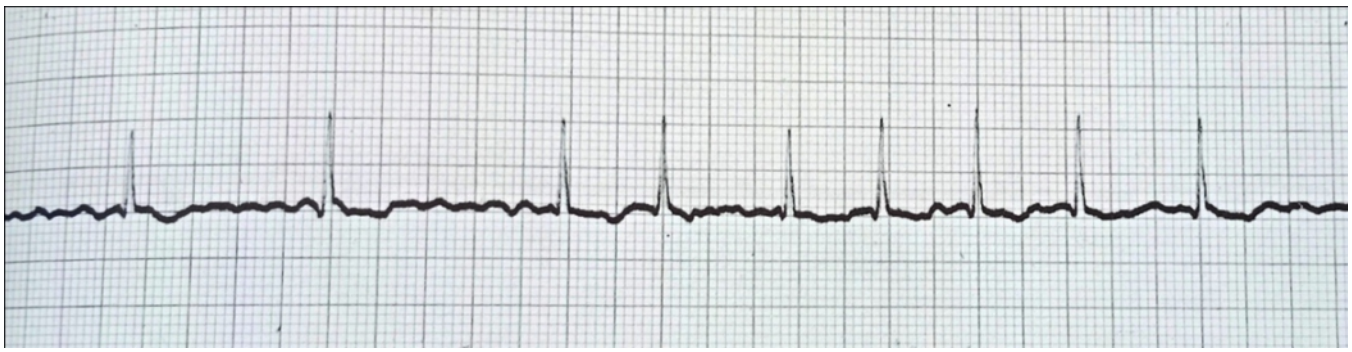

Figure 8: Classical Electrocardiographic Features of Atrial Fibrillation

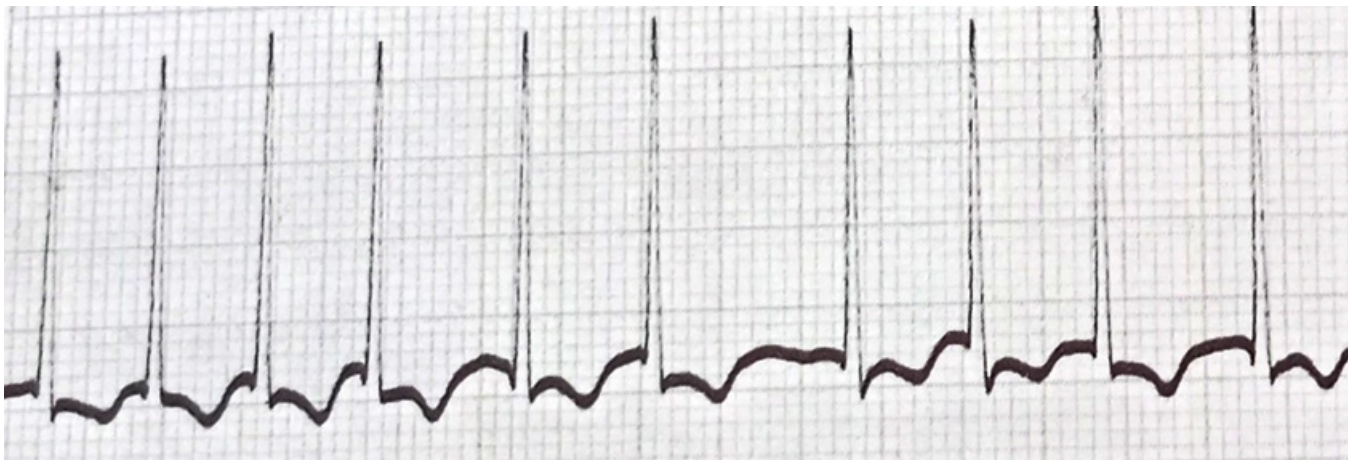

Figure 9: Atrial Fibrillation with Fast Ventricular Response

- 'Slow' AF is a term often used to describe AF with a ventricular rate < 60 bpm [Figure 10].

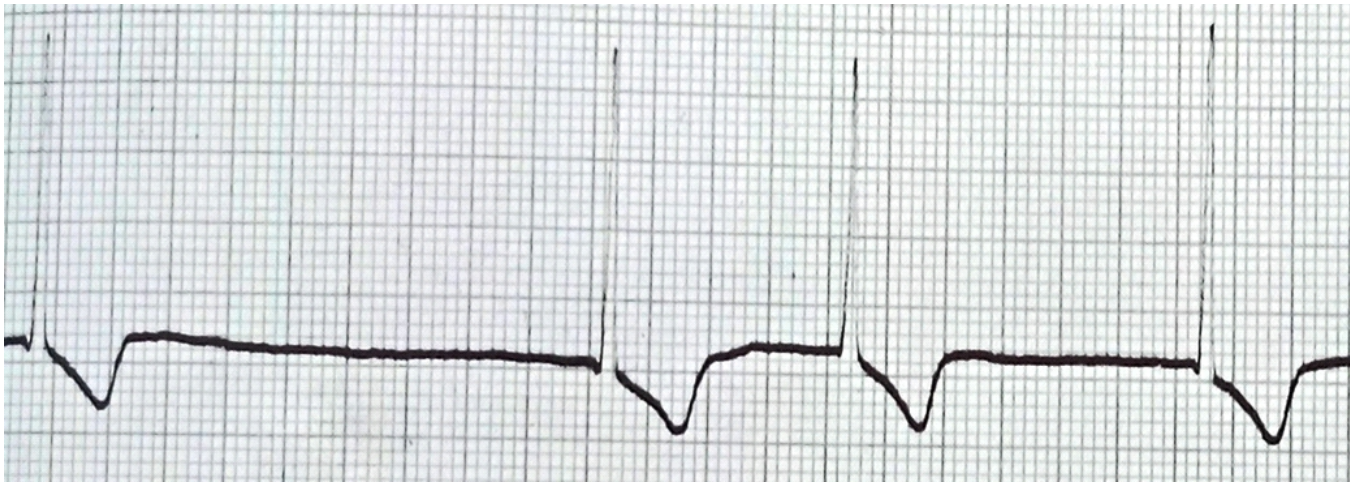

Figure 10: Slow AF - No Fibrillatory Wave Seen (Straight Line Fibrillation)

Causes of 'slow' AF include hypothermia, digoxin toxicity, medications, and sinus node dysfunction.

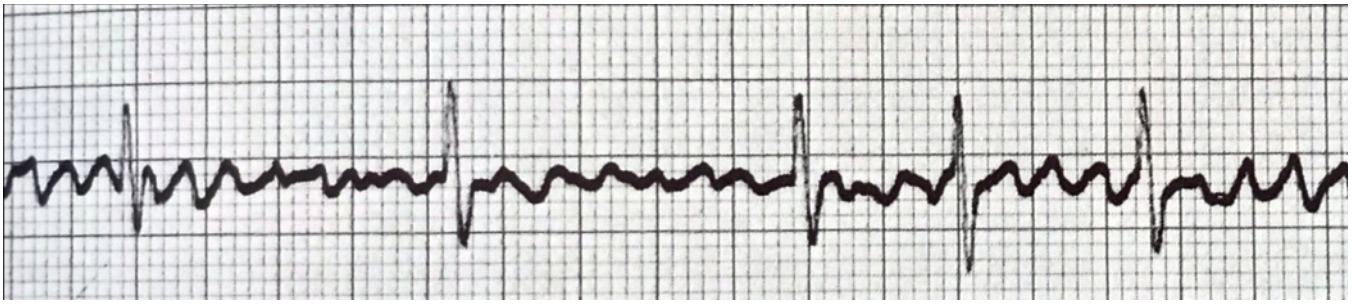

Figure 11: Flutter-Fibrillation

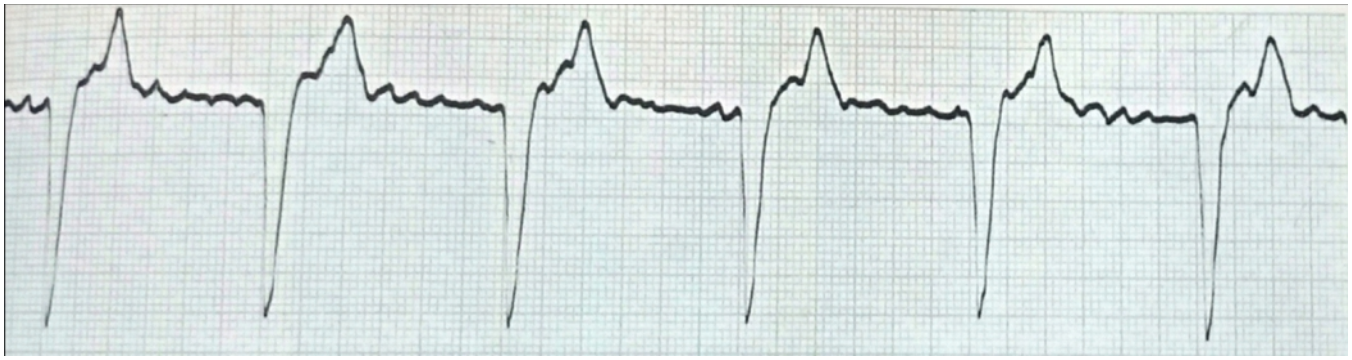

Figure 12: Atrial Fibrillation with Regular Ventricular Response (AF with CHB)

Radiological Evaluation:

The most frequent radiological findings are:

1) Left atrial enlargement;
2) Signs of pulmonary venous hypertension;
3) Signs of pulmonary arterial hypertension and
4) Cardiomegaly suggestive of right ventricular enlargement.

Kerley B lines, which are fine, parallel densities in the peripheral lung fields, running perpendicular to the pleural surface, most frequently seen in the costophrenic angles, signify severe pulmonary venous hypertension.

Evidence of pulmonary arterial hypertension, characterized by prominent pulmonary conus, prominence of the pulmonary arteries and their main branches, peripheral pruning of the small pulmonary arteries, and right ventricular enlargement. Calcification of mitral valve may be seen.

Echocardiography in AF[75,76]

Transthoracic echocardiography (TTE) is regarded as a routine part of the assessment in any patient with AF.

To identify structural heart disease giving the clinician a wealth of information regarding the underlying etiology and the subsequent management.

The echocardiography findings of MS reflect the loss of normal valve function. The fusion of commissures results in movement of the anterior and posterior leaflets anteriorly in parallel during diastole.

LA enlargement is seen. There may be overt causes of LA dilatation that are defined on TTE, e.g., mitral stenosis, or any cause of increased LV filling pressure. In lone AF, the presence of LA dilatation predicts adverse cardiovascular events.

LA dilatation may indicate adverse remodeling, but some debate remains as to whether AF is the initial cause or whether AF is in fact the end result.

Other critical observations that can be made, e.g., LV size/Geometry, presence of thrombus, valve disease, etc.

- In line with the ASE recommendations, the LV geometry is categorized as:
    - Normal Geometry
    - Concentric Remodeling
    - Concentric Hypertrophy
    - Eccentric Hypertrophy

These are the ASE recommendations:

- A high LV mass index (LVMI) is defined as >115 g/m2 for male patients and >95 g/m2 for female patients. (It is calculated using LVMI calculator);

  Left ventricular mass and left ventricular mass indexed to body surface area estimated by LV cavity dimension and wall thickness at end-diastole.

  LV mass (g) = $0.8\{1.04[([LVED + IVSd + PWd]^3 - LVEDD^3)]\} + 0.6$
- Relative wall thickness (RWT) was calculated using the following formula: (2 × PWd)/(LVEDd), to categorize an increase in the LV mass as either concentric (RWT > 0.42) or eccentric (RWT ≤ 0.42) hypertrophy and identify concentric remodeling (a normal LV mass with an increased RWT)[77,78].

Variable	Definition
LVEDD	LV end-diastolic dimension (mm)
IVSd	Interventricular septal thickness at end diastole(mm)
PWd	Posterior wall thickness at end diastole
1.04	Specific Gravity of the myocardium
Weight	weight(k.g.)
Height	Height(cm)

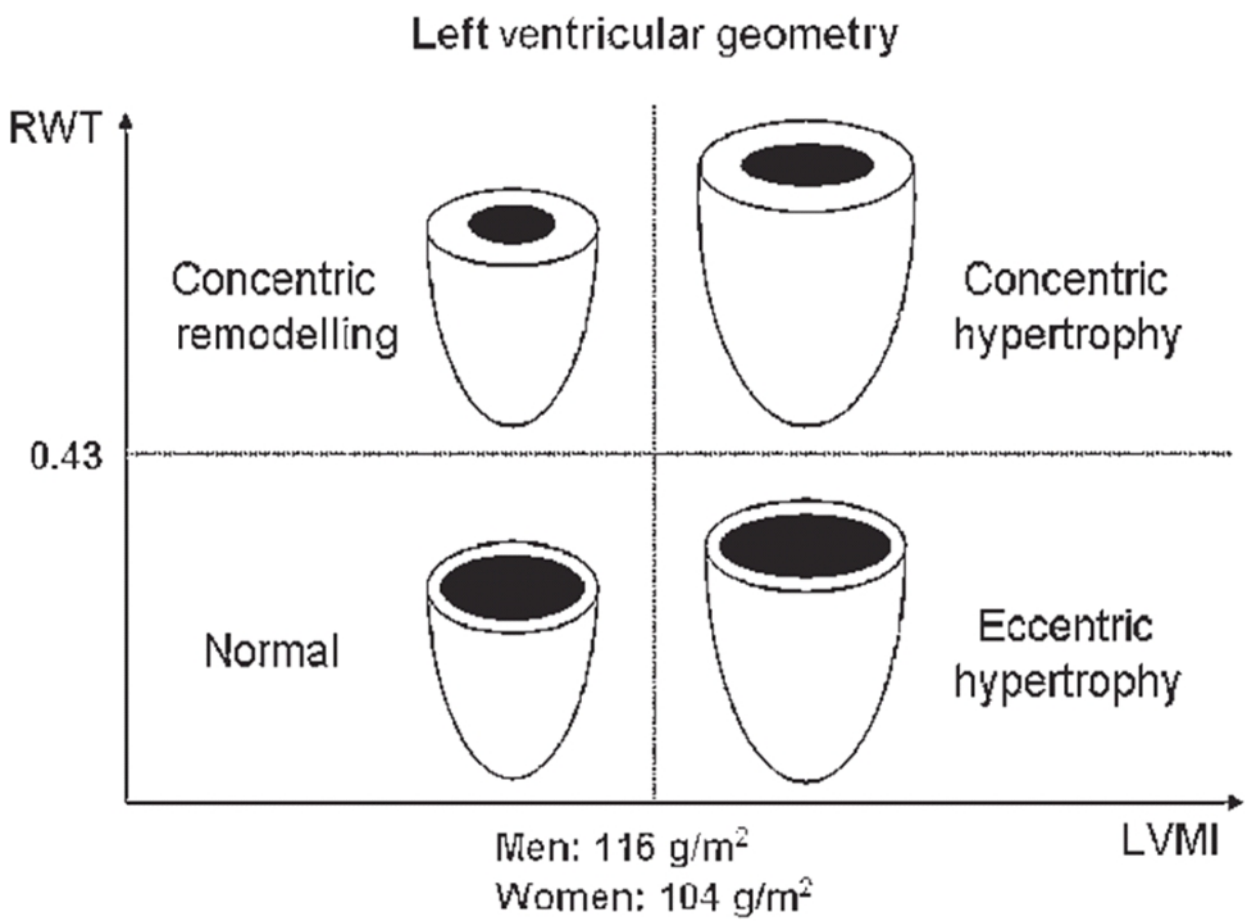

Figure 13: Left Ventricular Geometry according to RWT and LVMI[79]

When transthoracic echocardiography is unsatisfactory, transesophageal Echocardiography is a useful technique to assess the LA thrombus, the anatomy of the mitral valve and sub valvular apparatus and to assess the suitability of the patient for catheter balloon commissurotomy or surgical valve repair.

Advanced imaging technique like 3D Echocardiography provides a more accurate assessment of LA volume. If catheter ablation is being considered, cross sectional imaging with computed tomography or cardiac MRI offers detailed information regarding the pulmonary veins- their number, anatomy location and geometry. Late gadolinium enhancement MR sequences used to characterize the extent of left atrial fibrosis can predict response to catheter ablation of AF.

Ambulatory ECG (AECG) monitoring offers the ability to diagnose clinically suspected paroxysmal AF. Short term 24-48 hours continuous monitors have the advantage of documenting AF regardless of patient symptoms but with a trade-off for low sensitivity because of short-term of observation.

After the initial management of symptoms, the underlying cause of AF should be sought. A Thyroid function test (usually measures of serum thyroid stimulating hormone), a full blood count, a serum creatinine measurement and analysis for proteinuria, a measurement of blood pressure, and a test for diabetes mellitus (usually fasting blood glucose measurement) are useful. A stress test is reasonable in patients with signs or risk factors of coronary artery disease. Patients with persistent signs of LV dysfunction and/or signs of myocardial ischemia are candidates for coronary angiography.

Therapeutic Options

Therapeutic benefits achieved by treating atrial fibrillation have been proved beyond doubt. The principal priorities are to ameliorate the adverse hemodynamic consequences of poor cardiac output and to reduce thromboembolic risks. The first one is achieved by controlling the rate, reducing apex-pulse deficit, and conversion to normal rhythm, while the later one is achieved by anticoagulation.

Electrical and pharmacological cardioversion to normal sinus rhythm and to maintain the sinus rhythm are the optimal strategies to enhance cardiac performance and reducing the risk of thrombo-embolism. In this context cardioversion should be increasingly considered in the therapeutic armamentarium of

AF. The role of anticoagulants as prophylaxis agents against thrombo-embolism is more or less established. Several large, prospective randomized controlled clinical trials have consistently shown anticoagulation reduces the risk of strokes by about two third without significant development of adverse effects.

SUMMARY

Atrial fibrillation is a common arrhythmia encountered in clinical practice. It can result from different causes, varying from cardiac to non-cardiac conditions. It has variable clinical presentation from asymptomatic to dreadful conditions like congestive heart failure and stroke. The diagnosis rests on electrocardiogram supported by echocardiography. There is a wide variation in management strategies but the basic management rests on the three factors. First is the search for underlying cause and treat it accordingly. The second one is to control the rhythm and reduce the risk of thrombo-embolism, and the third is to consider cardioversion to sinus rhythm.

CONCLUSION

Atrial fibrillation is the most common arrhythmia in clinical practice having a substantial impact on morbidity and mortality. AF is linked with several conditions including RHVD, aging, thromboembolism, hypertension and left ventricular dysfunction. RHVD continues to be the most common cause of AF in India followed by IHD, and HTN. The presentation of AF is at a younger age group in the Indian population. Various complications are associated with AF of which CCF is the commonest complication followed by Embolism and Infective endocarditis. 2D Echo helps in evaluating the underlying cause and the presence of LA thrombus. Most of the cases of atrial fibrillation are associated with large left atrial size. Efforts to minimize the load of RHVD along with proper treatment and prophylaxis for the same can decrease the load of AF in the population and its associated complications.

CONFLICT OF INTEREST: None

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REFERENCES

1. Silverman ME. From rebellious palpitations to the discovery of auricular fibrillation: contributions of Mackenzie, Lewis and Einthoven. Am J Cardiol 1994; 73:384 –9.
2. Braunwald E. Shattuck lecture— cardiovascular medicine at the turn of the millennium: triumphs, concerns and opportunities. N Engl J Med1997; 337:1360 –9.
3. Gersh BJ. The epidemiology of atrial fibrillation and atrial flutter. In: DiMarco JP, Prystowsky EN, editors. Atrial Arrhythmias: State of the Art. Armonk, New York: Futura Publishing, 1995:1–22.
4. Wolf PA, Abbott RD, Kannel WB. Atrial fibrillation as an independent risk factor for stroke: the Framingham Study. Stroke. 1991 Aug 1;22(8):983-8.
5. Lip GY, Beevers DG. ABC of atrial fibrillation. History, epidemiology, and importance of atrial fibrillation. BMJ: British Medical Journal. 1995 Nov 18;311(7016):1361.
6. Adell CT, Samaniego SF, Casals BC, Maymó PN, Fandos OJ, Juncadella GE. Total arrhythmia due to atrial fibrillation. The primary care approach. Atencionprimaria. 1993 Apr;11(7):333-6.
7. Raman TK. Auricular Fibrillation. Indian Heart J 1951; 39:289-91.
8. Acierno LT. The history of cardiology. New York: Parthenon Publishing 1994.
9. Dr. P.C. Manoria. Monogram on Atrial Fibrillation. Gandhi Medical college, Bhopal: Dr. P.C. Manoria; 2016.
10. Mann, D, Zipes, D, Libby, P, bonow, R. Braunwald's Heart Disease: A Textbook of Cardiovascular Medicine. (10 ed.).: ELSEVIER; 2014.
11. Ed burns, D.R. Atrial Fibrillation. [Online]. Available from: https://litfl.com/atrial-fibrillation-ecg-library/ [Accessed 7 October 2019].
12. Prystowsky EN. Tachycardia included tachycardia: a mechanism of initiation of atrial fibrillation. In: Dimarco JP, PrystowskyEn, eds. Atrial Arrhythmias: state of the art. Armonk, NY: Futura publication Co: 1995: p81-95.
13. Coumel P. Neurogenic and hormonal influences of the Autonomic Nervous system in the determination of paroxysmal atrial fibrillation. In: atteul P, Coumel P, Janse MJ, eds. The Atrium in Health and Disease. Mount Kisco, NY: Futura Publication Co; 1989:213-232.
14. FRED F. FERRI. Ferri's Clinical Advisor 2018. Philadelphia, United States: ELSEVIER; 2018.
15. Pape LA, Price JM, Alpert JS, Ockene IS, Weiner BH. Relation of left atrial size to pulmonary capillary wedge pressure in severe mitral regurgitation. Cardiology 1991; 78:297–303.
16. Appleton CP, Galloway JM, Gonzalez MS, Gaballa M, Basnight MA. Estimation of left ventricular filling pressures using two dimensional and Doppler echocardiography in adult patients with cardiac disease. Additional value of analyzing left atrial size, left atrial ejection fraction and the difference in duration of pulmonary venous and mitral flow velocity at atrial contraction. J Am CollCardiol 1993; 22:1972– 82.

17. Simek CL, Feldman MD, Haber HL, Wu CC, Jayaweera AR, Kaul S. Relationship between left ventricular wall thickness and left atrial size: comparison with other measures of diastolic function. J Am SocEchocardiogr 1995; 8:37– 47.
18. Mehta S, Charbonneau F, Fitchett DH, Marpole DG, Patton R, Sniderman AD. The clinical consequences of a stiff left atrium. Am Heart J 1991; 122:1184 –94.
19. Hoogsteen J, Hoogeveen A, Schaffers H, Wijn PF, van der Wall EE. Left atrial and ventricular dimensions in highly trained cyclists. Int J Cardiovasc Imaging 2003; 19: 211–7.
20. Moe GK, Abildskov JA. Observations on the ventricular dysrhythmia associated with atrial fibrillation in the dog heart. Circ Res 1964; 4:447–460.
21. Li D, Fareh S, Leung TK, Promotion of atrial fibrillation by heart failure in dogs: remodeling of a different sort. Circulation 1999; 100:87–95.
22. Tai C-T, Chen S-A, Tzeng J-W, et al. Prolonged fractionation of paced right atrial electrograms in patients with atrial flutter and fibrillation. J Am CollCardiol 2001; 37:1651–1657.
23. Mary-Rabine L, Albert A, Pham TD, et al. The relationship of human atrial cellular electrophysiology to clinical function and ultrastructure. Circ Res 1983.
24. Zou R, Kneller J, Leon IJ, Nattel S. Substrate as a determinant of fibrillatory activity maintenance in a mathematical model of canine atrium. Am J Physiol 2005 ;289. 77.
25. Shi Y, Duchane A, Li D Gaspo R, Nattel S, Tardiff JC, Remodeling of atrial dimensions and emptying function in canine models of atrial fibrillation. cardiovascular Res ;2001;52;217-225.
26. Pongratz G, Brandt Pohlman M, Henneke KH et al. Platelet activation in embolic and pre-embolic status of patients with non – rheumatic atrial fibrillation. Chest 1997; April 929-933.
27. Ramirex – Lassepas M, Cippole RJ, Bjork RJ et al. Can embolic stroke be diagnosed on the basis of neurological criteria? Arch Neuro. 1987; 44:87-89.
28. Abemathy WS, Willis PS. Thromboembolic complications of rheumatic heart disease. Cardiovascclin. 1997; 5: 131-175.
29. Peterson P, Boysen G, Godtfredson J et al. Placebo controlled randomized trial of warfarin and aspirin for prevention of thromboembolic complication of chronic atrial fibrillation. Copen Hagen, AFA SAK study, Lancet. 1989;175- 179.
30. Daoud EG, Weiss R, Bahu M et al. Effect of an irregular ventricular rhythm on cardiac output. Am. Jour. Cardiol. 1996; 78: 1433-1436.
31. Gossolink ATM, Gijins HJ, Vanden Berg MP et al. Functional capacity before and after cardioversion of AF. A controlled study. Br. Heart. J. 1994; 72: 161-66.
32. 70 Farina E, Dihanro L, Magni E, Ambrosini S. Neuropsychological deficits in AF. Subclinical cognitive defects in AF. Neurology. 1996; 46 (3 suppli) A 139.78.
33. Reichek N, Shelburne JC, Perloff JK: Clinical aspects of rheumatic heart disease. ProgCardiovasc Disease 15: 491, 1973.
34. Davies MJ, Pomerance A: The morphological basis of atrial fibrillation in man. Br Heart J 34: 520, 1972.
35. Wilberth S, Aronow, Kenneth S Schwartz, Mordealkoenigsberg, prevalence of enlarged left atrial dimension of echocardiography and its correlation with left atrial fibrillation and an abnormal P terminal force; in Lead, of cardiology 1987, vol 5, 1095-1096.
36. Ho SY, Sanchez-Quintana D, Cabrera JA, Anderson RH. Anatomy of the left atrium: implications for radiofrequency ablation of atrial fibrillation. J CardiovascElectrophysiol 1999; 10: 1525 – 1526.
37. Papazoglou N, Atrial fibrillation and Mitral Stenosis, Circulation, 49;1019-20, 1974.
38. Peterson P, kastrup J, Brinck K et al. Relation between left atrial dimension and duration of atrial fibrillation Am J Cardiol, 60; 382-84, 1987.
39. Brodsky MA, Allen BJ, Capparelli EV et al. Factors determining maintenance of sinus rhythm after chronic atrial fibrillation with left atrial dilatation, Am J Cardiol, 63;1065-8, 1989.
40. Sanfilippo AJ, Abascal VM, Sheeshan et al. Atrial enlargement as a consequence of atrial fibrillation; a prospective echocardiographic study; Circulation.79.
41. Saurez GS, Lampert S, Ravid S Changes in left atrial size in patients with lone fibrillation, Clin CARDIOL, 11 (8), 652-6, 1991.
42. Vaziri SM, Larsen MG, Benjamin EJ, et al Echo cardiographic predictors of nonrheumatic atrial fibrillation; Framingham heart study, circulation, 89 ;724-30, 1994.
43. Flaker GC, Kristin A, Rothbart RM. Clinical and echocardiographic features of intermittent atrial fibrillation that predict recurrent atrial fibrillation. AM J Cardiol 76;355-58, 1995.
44. Arnow WS, Ahn C, Kronzan I. Echocardiographic findings associated with atrial fibrillation in 1699 patients aged >60 years; AM J Cardiol, 76;1191-92, 1995.
45. Rostango C, Olio G, Comeglio M, et al, left atrial size changes in patients with paroxysmal lone atrial fibrillation, Angiology, 47;797-801, 1996.

46. Fraser HRL, Turner RWD, auricular fibrillation with special reference to rheumatic heart disease. Br med J 2;1414, 1955.

47. Thiedeman KU, Ferrans UJ, left atrial ultra-structure in mitral valvular disease. AM J pathol, 89 ;575, 1977.

48. Takashashi N, Imataka K, Seki A et al, left atrial enlargement in patients with paroxysmal atrial fibrillation, JPN Heart J, 23(5) 677-83, 1982.80.

49. Gad Keren. Tahel E, Jack S, Alan AZ, Rebecca M. atrial fibrillation and atrial enlargement in patients with mitral stenosis; AM heart J 114 ;1146- 1155;1987.

50. Conradie C, Schall R, Marx JD. Echocardiographic study of left atrial thrombi in mitral stenosis. ClinCardiol 16(10);729-31, 1993.

51. Furberg CD, Psaty BM, Monolio TA, et al. Prevalence of atrial fibrillation in elderly subjects (The cardiovascular health study). Am J Cardiol 74:236-41, 1994.

52. Gupta V, Agarwal S, Mohrotra A, et al. Left atrial enlargement as a predictor of fibrillation in rheumatic mitral valve disease. JAPI, 44;903, 1996.

53. Moreyra AE, Wilson AC, Deac R, et al. Factors associated with atrial fibrillation in patients with mitral stenosis: A cardiac catheterization study. Am J, 135:138-45, 1998.

54. Mrozowska E, Rogowski W, Musial WJ, et al. Atrial fibrillation in mitral valve disease-risk factors. Pol Arch Med Wewn, 1010(1);45-53, 1993.

55. G Singh, P Arora study of left atrial size in atrial fibrillation JAPI ;50 ;50, 2002.

56. Kulkarni AG, Mulay DV, P jila. A study of relation between left atrial size and atrial Fibrillation JAPI, 50 ;1555, 2002.

57. Paulus Kirchhof, Angelo Auricchio, JeroenBax, Harry Crijns, John Camm, Hans-Christoph Diener, Andreas Goette, GerdHindricks, Stefan Hohnloser, Lukas Kappenberger, Karl-Heinz Kuck, Gregory Y.H. Lip, Bertil Olsson, Thomas Meinertz, Silvia Priori, Ursula Ravens, Gerhard Steinbeck, Elisabeth Svernhage, Jan Tijssen, Alphons Vincent, Günter Breithardt, Outcome parameters for trials in atrial fibrillation: executive summary: Recommendations from a consensus conference organized by the German Atrial Fibrillation Competence NETwork (AFNET) and the European Heart Rhythm Association (EHRA), *European Heart Journal*, Volume 28, Issue 22, November 2007, Pages 2803–2817.

58. Dorian P, Dorian P, Guerra PG, Guerra PG, Kerr CR, Kerr CR, et al. Validation of a New Simple Scale to Measure Symptoms in Atrial Fibrillation [Internet]. Circulation: Arrhythmia and Electrophysiology. 2009.

59. Friberg, Leif, Rosenqvist, Y.H. G. Evaluation of risk stratification schemes for ischaemic stroke and bleeding in 182 678 patients with atrial fibrillation: the Swedish Atrial Fibrillation cohort study.

60. Go AS. Prevalence of Diagnosed Atrial Fibrillation in Adults [Internet]. JAMA. American Medical Association; 2001.

61. Benjamin EJ. Independent Risk Factors for Atrial Fibrillation in a Population-Based Cohort [Internet]. JAMA. American Medical Association; 1994; 271:840-4.

62. Thomas, Glazer, Lumley, Longstreth, Smith, Psaty, et al. Blood Pressure Control and Risk of Incident Atrial Fibrillation [Internet]. OUP Academic. Oxford University Press; 2008; 21:1111-6.

63. Schmitt, Joern, Duray, Gabor, Gersh, J. B, et al. Atrial fibrillation in acute myocardial infarction: a systematic review of the incidence, clinical features and prognostic implications [Internet]. OUP Academic. Oxford University Press; 2008.

64. Rowe JC, Bland EF, Sprague HB, White PD. THE COURSE OF MITRAL STENOSIS WITHOUT SURGERY: TEN- AND TWENTY-YEAR PERSPECTIVES [Internet]. Annals of Internal Medicine. American College of Physicians; 1960.

65. Frost L, Vestergaard P, Mosekilde L, Hyperthyroidism and risk of atrial fibrillation or flutter: a population-based study. Arch Intern Med 1960:164:1675-8.

66. Cappola AR, Fried LP, Arnold AM, et al. Thyroid status, cardiovascular risk factors, and mortality in older adults. JAMA 2006; 295:1033-41.

67. Benjamin EJ, Levy D, Vaziri SM, et al. Independent risk factors or arial fibrillation in a population-based cohort. The Framingham Heart Study. JAMA 1994; 271:840-4.

68. Gami AS, Hodge DO, Herges RM, et al. Obstructive sleep apnea, obesity and the risk of incident atrial fibrillation. J AM COLL CARDIOL 2007:49:565-71.

69. Kodama S, Saito K, Tanaka S, et al. Alcohol consumption and risk of atrial fibrillation: a meta-analysis. J Am collCardiol 2011; 57:427-36.

70. Mukamal KJ, Tolstrup JS, Friberg J, et al. Alcohol consumption and risk of Atrial fibrillation in men and women: the Copenhagen City Heart Study. Circulation 2005;112:1736-42.

71. Moran BJ, Towbin JA, Thiene G, AntzelevitchC, Corrado D, Arnett D, Moss AJ, Seidam CE, Young JB. Contemporary definitions and classification of the cardiomyopathies: an American Heart Association Scientific Statement from the council of clinical cardiology, Heart failure and transplantation committee; Quality of care and outcomes research and functional genomics and translational Biology Interdisciplinary Working Groups; and council on Epidemiology and prevention. Circulation 2006;113:1807-1816.

72. Fox CS. Parental Atrial Fibrillation as a Risk Factor for Atrial Fibrillation in Offspring [Internet]. JAMA. American Medical Association; 2004.

73. Kirchhof, Paulus, Bax, Carina, Calkins, Hugh, et al. Early and comprehensive management of atrial fibrillation: executive summary of the proceedings from the 2nd AFNET-EHRA consensus conference 'research perspectives in AF' [Internet]. OUP Academic. Oxford University Press; 2009.

74. Hodgson-Zingman DM, Karst ML, Zingman LV, Heublein DM, Darbar D, Herron KJ, et al. Atrial natriuretic peptide frameshift mutation in familial atrial fibrillation [Internet]. The New England journal of medicine. U.S. National Library of Medicine; 2008.

75. Olson TM, Michels VV, Ballew JD, Reyna SP, Karst ML, Herron KJ, et al. Sodium channel mutations and susceptibility to heart failure and atrial fibrillation [Internet]. JAMA. U.S. National Library of Medicine; 2005.

76. Douglas PS, Garcia MJ, Haines DE, Lai WW, Manning WJ, Patel AR et al. ACCF/ASE/AHA/ASNC/HFSA/HRS/SCAI/SCCM/SCCT/SCMR 2011 Appropriate Use Criteria for Echocardiography A Report of the American College of Cardiology Foundation Appropriate Use Criteria Task Force, American Society of Echocardiography, American Heart Association, American Society of Nuclear Cardiology, Heart Failure Society of America, Heart Rhythm Society, Society for Cardiovascular Angiography and Interventions, Society of Critical Care Medicine, Society of Cardiovascular Computed Tomography, and Society for Cardiovascular Magnetic Resonance Endorsed by the American College of Chest Physicians. J Am CollCardiol 2011;57:1126–66.

77. Wheeler R, Masani ND. The role of echocardiography in the management of atrial fibrillation. European Journal of Echocardiography 2011;12:i33–i38.

78. Lang, R. M. et al. Recommendations for cardiac chamber quantification by echocardiography in adults: an update from the American Society of Echocardiography and the European Association of Cardiovascular Imaging. J. Am. Soc. Echocardiogr. 28, 1–39. e14 (2015).

79. Seko Y,Kato T, Haruna T, Izumi T et al. Association between atrial fibrillation ,atrial enlargement and left ventricular geometric remodeling. Nature News. Nature Publishing group; 2018.