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Circadian Rhythms and Seasonal Incidence of Cardiac Arrhythmia in Cardiovascular Patients

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Abstract

Objectives: Cardiovascular diseases are one of the most common causes of inability and mortality in most countries. External and internal factors, especially circadian rhythms can play a significant role in the incidence of heart attacks and supraventricular arrhythmias. Various changes in the biological conditions of body lead to these rhythmic changes, as well as circadian cycles and seasonal incidence. The occurrence of cardiac arrhythmias fluctuates during the day and night. However, seasonal variations and night-time sleep are among the reasons for a decrease in the incidence of such arrhythmia.

Materials and Methods: This study is descriptive research. The population of the study included patients who referred to the emergency room and inpatient centers of Shahid Madani teaching hospital of Tabriz. A total of 722 patients were examined during September 2008-2010. Data were analyzed using the SPSS, version 16.

Results: Two types of arrhythmia including the atrial fibrillation (AF) and none-AF occurred in 480 (63%) and 292 (37%) individuals, respectively. In addition, as regards the seasonal distribution of arrhythmia, the highest incidence rate was 225 (29.1%) in spring. Further, in terms of the hour of incidence and the related percentage, arrhythmias were recorded during a circadian period and as follows: 00.00-4.00 (10. 2%), 4.00-8.00 (5.4%), 8.00-12.00 (34.9%), 12.00-16.00 (19.9%), 16.00-20.00 (16.5%), and 20.00-24.00 (12.6%).

Conclusions: Generally, changes in seasonal circadian rhythms are believed to play a role in the incidence of supraventricular arrhythmic attacks. Furthermore, it is assumed that internal hormonal and biochemical changes affect the occurrence of supraventricular arrhythmia. Therefore, identifying these seasonal and circadian rhythms can have important practical applications.

Keywords: Circadian rhythm, Seasonal incidence, Cardiac arrhythmia

Introduction

Generally speaking, rhythmic and circadian changes and seasonal incidence are identified for various diseases and cardiac pathophysiologic disorders such as sudden cardiac arrest, myocardial infarction, myocardial ischemia (MI), as well as atrial and ventricular arrhythmias (1). Moreover, based on previous findings, many cardiac arrhythmias have specific characteristics in terms of prevalence, continuance, and ending (2). Although much of the data regarding the occurrence of these arrhythmias are obtained from the patients (3), altogether this process is very difficult and mainly unreliable since many of the cardiac arrhythmias are asymptomatic and in most cases have a low rate of recurrence (4). However, using electrical devices implanted in the heart helps cardiologists a lot in order to determine the beginning and the circadian rhythm of these arrhythmias (5).

Different variables in biophysical systems demonstrate fluctuations in the courses of a 24-hour period. No acute cardiovascular incidents occur randomly but follow a specific daily pattern (6). The incidence of cardiac arrhythmias varies during the day and in different seasons and these arrhythmias reduce during the night-time sleep (7). The study of rhythmic changes and circadian cycles, as well as the seasonal incidence of cardiac problems and arrhythmias, is an introduction to diagnose and treat these diseases and their treatment (8). Additionally, circadian changes are influential in the incidence of cardiovascular incidents such as acute myocardial infarction, sudden cardiac death, thrombolytic stroke, and transient MI, particularly during a morning period from 6 AM to noon (6,9).

Atrial fibrillation (AF) is a widespread and annoying arrhythmia for both patients and doctors because its symptoms only develop in several patients. In addition, it is the second most common cause of cardiogenic stroke (10,11). Daily distribution of initial AF which is the beginning of chronic AF has not been clearly explored

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and there is only limited information about its beginning (12,13). Contrary to acute cardiovascular incidents, initial AF appears for a long period and finally disappears. If circadian rhythms are involved in its initiation, the efficacy of antiarrhythmic therapies can be affected (reinforced or mitigated) by these rhythms (14). Further, Irwin et al found that the peak incidence of tachycardia was at 4 PM and that its occurrence was 5 times more in the afternoon than the final hours of the day (13). Furthermore, based on some studies, these attacks most likely occur in the afternoon and evening. In this regard, Schwab reported that night-time ischemia in patients with a history of myocardial infarction and cardiac heart failure mostly happens in late evening (15). The effect of a 24-hour pattern on the incidence of angina pectoris, myocardial infarction, and sudden death was proved with the peak incidence between 6 am to 12 pm (16). Moreover, Negri et al indicated that the incidence of myocardial infarction was higher in the afternoon hours but lower between 3 and 7 am (17). Manfredini et al argued that myocardial infarction would generally happen in the morning (18). The results of the study by López Messa et al demonstrated that the majority of heart attacks occurred between 10 am to 5 pm and that the emergence of symptoms followed a sinus rhythm (19).

Therefore, different communities with varying characteristics represent different patterns respecting the incidence of cardiac attacks. Identifying circadian rhythms in cardiac incidents among various communities could help to deeply understand the disease process, determine vulnerable hours, and ultimately to implement preventive mechanisms such as drug protection and caring measures regarding high-risk hours. Previous studies were conducted many years ago in this respect. Accordingly, considering the importance of determining the time of these changes in diagnosing these diseases along with the lack of research in this field, the present study aimed to specify circadian and seasonal changes regarding the incidence of cardiac arrhythmias.

Materials and Methods

A number of 722 patients (294 males and 428 females) who referred to the emergency room and inpatient centers of Shahid Madani teaching hospital of Tabriz were recruited in this descriptive research and studied during September 2008-2010. Medical records of all the patients with cardiac arrhythmia were examined. Additionally, patients received no drug during this period. A two-part tailor-made questionnaire was used to collect the required data. The first part of the questionnaire collected demographic data, that is, information about the participants' name, gender, place of residence, and their level of education and the second part was related to cardiac information and other variables. The Statistical Package for the Social Sciences (SPSS) software, version 16 was run to analyze the collected data.

Inclusion Criteria

All the patients diagnosed with supraventricular arrhythmia who were categorized into AF and non-AF groups.

Results

Totally, 722 patients participated in the present study out of whom 38% (n = 294) were males and 66% (n = 428) were females. The average age of the participants was 45.87 ± 14.95 years of whom 372 (52%) patients lived in the city of Tabriz while 350 (48%) of them resided in the surrounding villages. As regards the level of education, 101 (14%) participants were uneducated and 165 (26%) of them had under diploma education. In addition, 306 (34%) patients had high school diploma whereas the remaining patients held either associate (n =140, 21%) or bachelor (n = 10, 5%) degrees. Demographic characteristics of the study population are provided in Table 1. Further, a number of 260 (48%) patients had a history of high blood pressure while the remaining participants had diabetes (n = 200, 26%), a history of high blood lipids (n = 172, 18%), or were smokers (n = 90, 8%). The frequency distribution regarding the medical history of the participants is presented in Table 2. Furthermore, the patients (480 vs. 293) suffered from either AF (63%) or non-AF (37%). With regard to the seasonal distribution of arrhythmia, the highest incidence rate was equal to 225 (29.1%) in the spring. Moreover, in terms of the hour of incidence, the highest arrhythmias were recorded during 00.00-4.00 (10.2%). Table 3 demonstrates the incidence distribution of arrhythmia. The relationship between gender and the incidence of arrhythmia revealed that the onset of cardiac arrhythmia was higher in men (33.8%) during 4.00-8.00 while it was higher in women (44.2%) during 20.00-24.00 (Table 4). However, based on Table 5, there was no significant correlation between the type of

Table 1. Demographic Characteristics of the Population

Variable		No. (%)
Gender	Male	294 (38)
	Female	428 (66)
Residence	City	372 (52)
	Village	350 (48)
Level of education	Uneducated	101 (14)
	High school/diploma/lower	471 (60)
	University degree	150 (26)

Table 2. Frequency Distribution of Medical History of the Particiapants

Variable	No. (%)
Hypertension	260 (48)
Diabetes	200 (26)
Hyperlipidemia	172 (18)
Smoke	90 (8)

Table 3. Incidence Distribution of Arrhythmias Based on the Season Variables of the Year and Hours

	Spring	Summer	Autumn	Winter	Total
00:00 – 4:00	25 (36.2%)	24 (34.8%)	12 (17.4%)	8 (11.4%)	69 (100%)
4:00 – 8:00	16 (34.8%)	7 (15.2%)	11 (23.9%)	12 (26.1%)	46 (100%)
8:00 – 12:00	48 (35.3%)	31 (22.8%)	26 (19.1%)	31 (22.8%)	136 (100%)
12:00 – 16:00	46 (27.5%)	45 (26.9%)	31 (18.6%)	45 (26.9%)	167 (100%)
16:00 – 20:00	43 (27.9%)	34 (22.1%)	43 (27.6%)	34 (22.1%)	154 (100%)
20:00 – 24:00	47 (23.5%)	63 (31.5%)	36 (18%)	54 (27%)	200 (100%)
Total	225	204	159	184	722
Total patient with arrhythmia	7038	6922	6960	7750	28670
Percentage of arrhythmias in total patients	3.19%	2.94%	2.28%	2.37%	2.69%

Table 4. The Relationship Between the Patients' Gender and the time of Arrhythmias Occurrence

Variable		Day Hours 00:00-4:00	Day Hours 4:00-8:00	Day Hours 8:00-12:00	Day Hours 12:00-16:00	Day Hours 16:00-20:00	Day Hours 20:00-24:00
Gender	Male	51 (20.4%)	84 (33.8%)	48 (18.9%)	41 (12.5%)	38 (10%)	36 (4.4%)
	Female	35 (5.6%)	30 (1.4%)	45 (11.2%)	56 (14.3%)	82 (22.3%)	180 (44.2%)

Data are presented in numbers (%).

arrhythmia and gender ($P = 0.13$). Age scattering which is based on the type of arrhythmia is illustrated in Figure 1.

Discussion

The results of the present study indicated that the peak incidence of AF was during 8.00-12.00 AM. Hjalmarson et al reported that 28% of the research population experienced the peak incidence of arrhythmia between 6 AM and 12 PM and the lowest incidence was between 6 PM and 21 PM (20). Additionally, Abdar Esfahani et al found that the peak incidence of arrhythmia (40.4%) belonged to the time between 6 AM and 12 PM, as well as between 6 PM and 12 AM (25%) (21). The relationship between gender and the incidence time of arrhythmia revealed that the peak incidence of arrhythmia in men and the lowest incidence in women was during 4.00-8.00 while the peak incidence of arrhythmia in women and the lowest incidence in men was during 20.00 to 24.00. This could be attributed to the difference in how men and women interact or participate in social-economic and environmental activities. In addition, Lee et al reported that the incidence and the duration of paroxysmal supraventricular tachycardia (PSVT) had a circadian rhythm (22).

AF was considered a difficult disorder in the past due to its intermittent and occasionally asymptomatic nature (12,13). Clair et al found no relationship between the AF and circadian rhythm (12) while Rostagno et al (23) and Kupari & Leinonen (23) highlighted 2 peaks of AF in relation to circadian rhythms. Further, the present study found 2 peaks of AF with the highest incidence peak of arrhythmia during 4.00-8.00 followed by the peak occurring during 12.00-16.00. The previous studies only focused on the onset of the symptomatic part when patients referred to the emergency room and perform electrocardiography (12,13). Therefore, the obtained data only represent the symptomatic part of the disease and were based on the onset time of the symptoms instead of the onset time of the actual arrhythmia. Conversely, however, the current study completely reviewed the patient's record during admission and hospitalization

Table 5. Variants of the Examination Based on Type of Arrhythmias

	AF	Non-AF	*P* Value
Total patients	479 (64%)	293 (56%)	
Age	60.97 ± 14.15	50.42 ± 16.18	< 0.0001
Gender			0.13
Male	219 (45.7%)	121 (41.3%)	
Female	260 (54.3%)	172 (58.7%)	

Abbreviation:AF, atrial fibrillation.
Data are presented in numbers (%) and Mean ± SD.

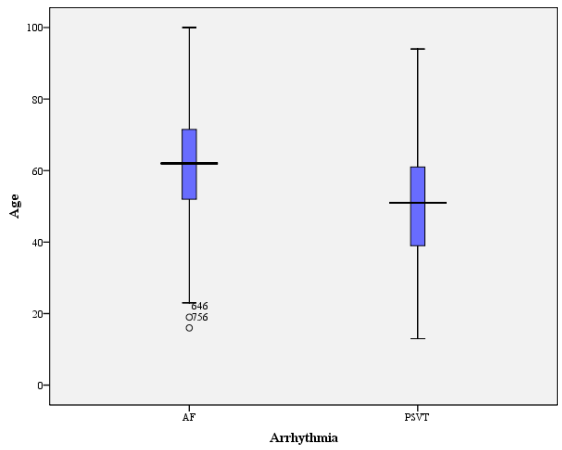

Figure 1. Age Scattering Based on the Type of Arrhythmia Developed in the Patients.

periods. Furthermore, the time of the onset of symptom and rhythm changes were observed during these periods or treatment of the patients.

As regards the other cardiovascular incidents, numerous results were obtained in relation to circadian rhythms. In some studies, no peak incidence of myocardial infarction was reported (25) while in the others the peak time of myocardial infarction attacks was observed in the morning hours (26,27). Stimulating the internal process (i.e., increased adrenergic activity, blood pressure, heart rate, platelet adhesion, and the like) after waking and beginning of physical activities and mental stress are indicated as the possible causes of these incidents. Additionally, Salehian et al emphasized the effect of activity and mental stress on the time of attack (25). In addition, Dianati et al examined the effect of physical activities on the incidence of MI during different times of the day. Further, they investigated the impact of such activities on internal circadian rhythm in ischemic patients. Based on the results, a morning-time increase and an evening-time reduction were observed in MI pain with increased and decreased physical and mental activities, respectively (28). These results demonstrated that identifying the circadian rhythm played an important role in preventing the occurrence of MI.

In this study, means of the patients' ages with arrhythmias were 54.79 ± 15.65 (in spring), 58.41 ± 14.42 (in summer), 57.63 ± 15.6 (in autumn), and 57.37 ± 17.37 (in winter). These results indicate that the average age of these patients was higher in summer and winter when the temperature changes were greater than the longer range compared to the other seasons.

Therefore, it seems that different communities with varying characteristics represent different patterns with regard to the incidence time of cardiac attacks. Accordingly, by identifying the circadian rhythms in cardiac incidents in different communities one could obtain a deeper understanding of the disease process, determine vulnerable hours, and finally provide preventive mechanisms like drug protection and caring measures respecting the high-risk hours.

Conclusions

Generally, the findings of this study revealed that supraventricular arrhythmic attacks follow seasonal and circadian rhythms. Therefore, internal hormonal and biochemical changes are assumed to influence the incidence of supraventricular arrhythmia due to circadian cycles and seasonal changes and that identifying these seasonal and circadian rhythms provides important practical applications.

Ethical Issues

The study was approved by the Ethics Committee of Tabriz University of Medical Sciences (Code of Ethics: (IR.TBZMED.REC.1390.1-4.3).

Conflict of Interests

The authors declare that they have no conflict of interests.

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