The Epidemiology of Sudden Cardiac Death; a Forensic Autopsy Study in Iran 2013-2016

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Abstract

Background: Sudden cardiac death is the most common and deadliest manifestation of coronary artery disease that causes more deaths than any other cause each year. This study has been conducted with regard to the highly fatal and the high prevalence and the lack of adequate information in this area in our country.

Objective: To determine the epidemiological findings of sudden cardiac death in Tehran, Iran from April 2013 to April 2016.

Materials and Methods: In this descriptive-analytic cross-sectional study, referring to the forensic archives of Tehran Legal Medicine Organization, information was collected based on a researcher-made questionnaire from patients who died of natural symptoms within 24 hours of onset of symptoms. Using statistical software SPSS V16 data was subjected to descriptive and analytical reviews.

Results: Findings show that about 77% of male subjects with an average age of 58.05 years (SD=13.56), 41.5% of cases in the age range of 50 to 65 years, were generally free or retired from their job (47.8% and 25.3%). The most common cause of death was “heart attack” (more than 99%) and mainly the location of death was prehospital (50%), which occurred in 82% of cases during rest or during normal activity, and mainly during the initial hour (60%) and the most common time of death was 6 to 12 in the morning (39.6%). The mean heart weight was 380 g ±67.42, pulmonary fibrosis was 65%, and hyperemia was seen in 47%. The most common site of coronary involvement was LAD + RCA (77%).

Conclusion: Considering the rapid growth of sudden cardiac deaths over a three-year period, and considering the difference in the results of this research with similar research abroad, the need for the attention of clinicians to these differences could be helpful in the management of such valuable patients.

Key words: Epidemiology, Forensic, Autopsy, Sudden death, Sudden cardiac death
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Introduction

Sudden Cardiac Death (SCD) is defined as a sudden, unexpected death with a heart origin with or without an existing heart problem that occurs shortly after the onset of symptoms (up to an hour) (3-1). Ischemic heart disease is the most common cause of natural sudden death. Major causes of ischemic heart disease include coronary artery atherosclerosis, hypertensive heart disease, aortic valve disease, coronary artery disease, cardiomyopathy, congenital heart disease, and artery disease, such as polyarthritis (4). The prevalence of SCD in several studies in the United States, China, Ireland and the Netherlands has been estimated at a range of 50-100 per 100,000 populations (5-10).

Despite the decrease in the ischemic heart disease mortality, unfortunately the incidence of sudden death has increased and in 50% of cardiovascular patients, it is the first manifestation of the disease (11-12). Unfortunately, the majority of people with this disease have no symptoms and are not in the high-risk group. In societies that have extensive training for the recovery of heart disease patients, only 8% of hospitalized patients are alive (13) and since more than 90% of patients die before they reach the hospital, recognizing high-risk patients and prevention measures is very important (1).

One of the most important issues that has always been in the mindset of clinical professionals, is to know the cause of death in cases of sudden death. This is not possible for clinicians in most cases. On the other hand, even with a complete autopsy, sometimes it is difficult or impossible to understand the exact cause of death in some cases of sudden death (white autopsies) (14-14). Unfortunately, despite the advancement of medical technology, our knowledge of the causes and risk factors of sudden cardiac death, unlike other atherosclerotic diseases, is very limited (16). In our country, limited studies have been conducted on this disease. Due to referral of many dead people fewer than 24 hours from the onset of symptoms to the Legal Medicine Organization (LMO), the information in the forensic record may seem to be an authoritative and generalizeable source for the disease.

Materials and Methods

The present study is a cross-sectional, descriptive-analytic retrospective study. The Statistical population was all cases of sudden cardiac deaths referred to the LMO and the samples, of all the cases of sudden cardiac deaths were sent to LMO during the period between April 2013 to April 2016.

Sampling method was census and all samples were entered according to inclusion and exclusion criteria. Inclusion criteria were symptom onset up to one hour, and death because of cardiac causes and exclusion criteria was including suspicious, non-cardiac and abnormal deaths (such as poisoning, accident, stroke, acute pulmonary embolism, etc.). Data were collected in a researcher-made questionnaire with two parts. 1) Demographic information and individual history. 2) Autopsy findings. In all of the cases, autopsy was carried out by classical method and all necessary data including heart weight, fibrosis, hyperemia, coronary artery involement were extracted. Eventually, 2182 sudden cardiac death during 2013 to 2016 were reviewed. All data were collected in a researcher-made questionnaire. SPSS V16 software was used for mean, median, mode, standard deviations, and also Pearson chi square test or Fishers exact test for analysis of mean differences or ratios. In analytical cases, P value less than 0.05 was considered significant. This study, was in keeping with the Helsinki Code of Ethics.

Results

A total of 2,182 sudden cardiac deaths were referred to LMO during the three years 2013 to 2016. An increase in the annual trend of sudden cardiac death was seen. That means from 593 people (27.2%) in 2013, 793 people (33.4%) in 2014 and 861 people (39.5%) increase in 2015, which was statistically significant (0.04> P) (Table 1)

Table 1: Annual trend of sudden cardiac death in 3 years 2013-6

Year	Frequency	Percent	P value
2013	593	27.2	
2014	728	33.4	0.04
2015	861	39.5	
Total	2182	100	

A) Demographic Findings

Out of 2,182 sudden cardiac deaths during the three years 2013 to 2016, there were 1,678 men (76.9%) and 504 women (23.1%) (Ratio 3.2: 1). The mean age of the samples was 58 years with a standard deviation of 13.56, in the range of 23-90 years old. Table 2 reviews the frequency based on age groups. As seen from the 2,182 cases, the highest frequency was observed in the age group of 50-65 years (41.5%, 906 = n).

Table 2: Frequency of sudden cardiac death in 3 years 2013-6 based on age groups

Age groups	Frequency	Percent	P value
20-34	48	2.2	
35-49	527	24.2	
50-64	906	41.5	.000
65-80	574	26.3	
80<	127	5.8	
Total	2182	100	

In Table 3 it can be seen the data about the cases' occupation, place of death, cause of death, the time and duration of onset of symptoms to death, and physical conditions and activity.

Table 3: Frequency of sudden cardiac death in 3 years 2013-6 based on demographic variables

Variable	Frequency	Percent	P value
Occupation			
Self employed	1047	48	
Employee	297	13.6	
Retired	552	25.3	.000
Housewife	225	10.3	
Student	61	2.8	
Place of death			
Out of the hospital	1090	50	
At the entrance to the hospital	316	14.5	.000
Hospitalized in hospital	776	35.6	
Cause of death			
Merely a heart attack	1681	77	
Myocardial infarction and diabetes	199	9.1	.000
Myocardial infarction and kidney failure	233	10.6	
Myocardial infarction and hypertension	52	2.4	
Pulmonary heart disease	18	.8	
Duration of symptoms until death			
Less than 1 hour	1224	59.1	
Less than 3 hours	374	17.2	
Less than 6 hours	278	12.7	.000
Less than 12 hours	207	9.5	
Within 24 hours	99	4.5	
Conditions and physical activity			
While sleeping	79	3.6	
During the break	921	42.2	
During normal activity	860	39.4	.000
During moderate exercise	274	12.6	
During extreme sports	48	2.2	
Total	2182	100	

B) Autopsy findings

The mean heart weight was 67.42 ± 380.79 g, with a median of 410 g in the range of 330 to 730 g. After the classic disection and then the transverse, the findings of the existence of fibrosis and hyperemia were carefully investigated. 763 cases (35%) had no fibrosis and 929 (42.6%) cases had no hyperemia. Regarding the status of coronary artery involvement, 153 cases (7.2%) had no problem. The most cases of fibrosis were seen in left ventricular (523(243%)) and the interventricular wall (291(13.3%)). The highest incidence of coronary arteries involvement was in both LAD & RCA (1680(7780%). The single RCA (14(2.2%)) and single LAD (48(.9%)) involvement were the least. Table 4 deals with these findings.

Table 4: Frequency of sudden cardiac death in 3 years 2013-6 based on the presence of fibrosis, hyperemia and coronary artery involvement

Variable	Frequency	Percent	P value
Presence of fibrosis			
Left ventricle	523	24	
Right ventricle	137	6.3	
Both ventricles	206	9.4	.000
Interventricular wall	291	13.3	
Interventricular and left ventricular wall	203	9.3	
Papillary	59	2.7	
Could not be seen	763	35	
Hyperemia			
Left ventricle	465	21.3	
Right ventricle	83	3.8	
Both ventricles	52	2.4	.000
Interventricular wall	308	14.1	
Interventricular and left ventricular wall	297	3.6	
Interventricular and right ventricle	48	2.2	
Could not be seen	929	41.6	
Coronary involvement			
LAD	48	2.2	
RCA	14	.6	
LAD+RCA	1680	77	.000
3 Vessels	287	13.2	
Could not be seen	153	7.2	
Total	2182	100	

Conclusion and Dicussion

In this study, information was obtained by the demographic findings of corpses sent to Tehran LMO in the three years 2013, 2014 and 2015, which identified a sudden cardiac death as a cause of death. During these three years, there was an increasing trend in sudden cardiac death (P<0.000). There are several causes that can be mentioned; improvement in diagnostic methods, physicians' preference to refer bodies to forensic medicine in such situations, increased burden of heart disease in the community, increase in severity of heart disease, lack of therapeutic response, and so on. According to the study by Cathritiss et al in 2016 at the Atomic Clinic of Athens and Harvard College and the Mayo College in the United States, 50% of sudden deaths were due to sudden cardiac death, and this ratio remained unchanged despite a general decline in cardiac mortality (17). According to the study by Fabian Sachs Gumar et al at the University of Madrid Research Center in 2016, there has been a significant increase in sudden cardiac deaths, rising more than 1.8 times over the last 5 years (18). According to the study by Dinashe Rao, a legal expert on forensic pathologist in Jamaica during the years 2008 to 2011, by autopsy finding of 2,449 people, 204 had sudden cardiac death and had no significant increase compared to the previous years (19). In the study of Mark Eisen from the American Boston Heart Center's Medical Center in 2011, the incidence of sudden cardiac death in the American society is estimated at 300,000 to 250,000 per year with a slight mild increase in annual rates, and sudden cardiac death is generally responsible for more than 50% of cardiac mortality. (20).

In our study, the minimum age of patients who died due to sudden cardiac deaths was 23 with a maximum of 90 years, of which more than 75% were male, mostly in the age group of 50-65, 2.2% in the 20-35, 24.2, in 35-50, 42.5% in the 50-65, 26.3% in the 65-80, and 5.8% over 80 years old. The average age of the samples studied in this study was 58.05 years (standard deviation =13.56) with a mean age of 58 and mode 60-year. In the study of Rhajat deo and Hakaran from the Department of Cardiology at the University of Pennsylvania Philadelphia in 2011, the incidence of sudden cardiac death in the American society was between 180,000 and 450,000 per year and the risk increased with age, and males were more than women (21). According to Dinesh Rao et al's study, 62.24% of cases were in the age group of 50-60 years old and 28.43% in the age group of 60-69 years, and men were 10 times more involved than women (19). According to Dr Wu et al from the San Yatsen University Forensic Medicine Department of Guangzhou, China, during the period from 1998 to 2013, frequency of the sudden cardiac death was 43%, with a mean age of 38.2 years old and the highest

incidence was in the age group of 31-40 years; men were 4.3 times more likely to be involved than women. In this study, the majority of cases were free of job (47.8%) and then, retired (25.3%), employees (13.6%), and housewives (10.3%). There were also a few (2.8%) students among the sample of this study. In terms of the location of death, the largest out-of-hospital location (50%) included parks, vehicles, markets and streets, followed by death in the hospital (35.6%), and prehospital (14.5%). According to Dr Wu et al's study, 46.3% had sudden cardiac deaths in the hospital and 33.8% at home, and it was the highest in April-May (22). According to Dinesh Rao, the highest number of deaths (38.2%) occurred in the first hours (6 hours) of the onset of symptoms (19). In the study of Rajat Deo et al from the Department of Cardiology at the University of Pennsylvania Philadelphia in 2011, most cases occurred at home (21).

In our research, the onset of symptoms in the majority of cases were while resting or during normal activity (42.2% and 39.4%, respectively) and only 2.2% of the subjects had hard exercise. The onset of symptoms until death in most patients was less than one hour (59.1%), and about 90% of the patients died within less than 6 hours of onset of symptoms. The main cause of death in almost all patients was heart attack (99.2%). Myocardial infarction (MI) without any complications was found in 77% of cases, and MI with renal insufficiency, diabetes, and or hypertension was seen in others. In a study conducted by Miso Hayashi from the University of Nippon's Center for Cardiology at Tokyo University in an autopsy study in 2011, although the disease is called sudden cardiac death, about one third of patients died of other causes, such as bleeding or pulmonary embolism. (23). In the Mark Eestz study, the majority of patients didn't exist in the high-risk group, and even in societies with extensive training to rehabilitate patients with heart disease, only 8% of the patients left the hospital alive, and also the most common mechanism and cause of sudden cardiac death, was ventricular fibrilation (VF) (20).

In the Rajat Deo study, the risk of occurrence in the black race was more than white in any two-sex population, whose mechanism was not known; in men the cause of 80% of cases of sudden cardiac death was coronary disease, while in women 35%. The frequency of cardiomyopathy in women was 19% and in men 10%, and the heart was normal in in 10% of cases in women and 3% in men. The most common arrhythmias have been associated with sudden cardiac death was related to ventricular thromboembolism (63%). Lower concentrations of magnesium were with a lower risk for sudden cardiac death and higher concentrations of trans fatty acids have been associated with higher risk. The CRP factor in men has been shown to be related to sudden cardiac death but in men not seen (21).

According to the Fabian Sachs Gumar study, sudden cardiac deaths occur in 62-85% of people with coronary heart disease, and in 15% of cases, sudden cardiac deaths are the first coronary manifestation (without previous history), as well. In the follow up of four years of patients with a history of myocardial infarction, about one quarter of cases occurred during the first three months and half of sudden cardiac deaths occurred during the first year, with a higher risk for those with a lower ejection fraction (EF) of 35%. On the other hand, although a history of heart problems such as heart attacks and heart failure is associated with a higher risk of sudden cardiac death, 80% of the sudden cardiac deaths were asymptomatic patients and had no previous history, and in general, the risk of sudden cardiac deaths in women was at least a half of men (18).

Based on the study of catarrhosis, the most common cause of sudden cardiac death is primarily (50%) due to coronary artery disease and its ischemia, and then due to cardiomyopathy and genetic canalopathy (long QT syndrome, Borghada, etc.). Also, in sudden deaths occurring in sports, only about 25% of the cases have been diagnosed, of which 75% are associated with acute cardiac disease. Sudden cardiac deaths in the black race are twice as likely to occur than in white. In cases under 35 years of age, the most common cause of sudden cardiac death was arrhythmia, and in general, between 5% and 20% of cases of sudden cardiac death, no significant finding was found in autopsy (17).

In addition to demographic findings, in this study, the findings of the autopsy were extracted and analyzed. The average heart weight was 380.79 g (standard deviation = 67.42), with a median of 410 g and mode of 400 g in a range of 330 g to 730 g. 25% of the samples were less than 390 g and 75% of them weighed less than 480 g. Cardiac fibrosis was seen in 65% of the samples, with the highest in free left ventricular wall (24.0%) and then interventricular wall (13.3%). The lowest amount was observed on papillary muscle (2.7%). In terms of hyperemia, in about 42% of cases it was not observed. Left ventricle (27.3%) and subsequently interventricular wall (19.9%) were the most common hyperemia sites. In terms of coronary artery disease, about 93% of the cases had moderate to severe involvement, and the most common involvement was LAD and RCA (77.0%), followed by 3 Vessels (13.2%), LAD (2.2%) and finally RCA (0.6%). According to a study by Dr. Wu et al., The most common cause of sudden cardiac death was 41.6% related to coronary disease, followed by sudden unexplained death of 15.1% and myocarditis 11.8%. Of course, in patients under the age of 35 years, myocarditis and sudden unspecified death had a higher incidence of coronary disease.

Based on the anatomical area of coronary involved, single vessel coronary involvement was more than 2 and 3 vessels (47% vs. 39.7% &16.2%; p=0.001), and in general, the LAD branch had the highest rate of disease (95.4%), and the involvement of all three vessels increases with age. Also, the higher and more severe degrees of coronary involvement (grade 4) were in 67.2% of cases; the highest rates were seen at older ages. According to the Dinesh Rao study, the main cause in those cases were coronary disease (51.5% RCA & 42.6% LAD), and the involvement of all three major vessels in the age group of 50 to 59 years was more prevalent. In younger subjects,

the incidence of LAD was higher (proximal 3 to 5 cm of the anterior descending LAD) and, generally, the rate of involvement and obstruction in the LAD was greater than RCA (48.53% vs. 8.82%). Also, 39.2% died at home and 24% were hospitalized before death (19).

The aim of this study was to determine the epidemiological characteristics of sudden cardiac death among bodies submitted to the Tehran LMO. It has been mentioned that all such patients are not referred to LMO for forensic autopsy; a death certificate can be made by the physician by detecting normal death in a hospital, and or clinic, especially in patients with a history of heart attacks. So the results of our study can not be generalized to the community of all patients with sudden cardiac sudden. However, given the fact that autopsy can better find out the epidemiological features of sudden cardiac death and in most countries, including Iran, hospital autopsy (non forensic autopsy) is restricted, so the findings of this study can be helpful in finding out some of the epidemiological characteristics of sudden cardiac death.

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