Original Article

Bull Emerg Trauma 2016;4(4):202-210.

Bulletin of Emergency And Trauma

Increased Likelihood of Arrhythmic Events Associated with Increased Anxiety in Patients with Implanted Cardiac Defibrillators after the Ahar-Varzegan Earthquake in East Azarbaijan, 2012

Fatemeh Ranjbar[1], Fariborz Akbarzadeh[1], Babak Kazemi[1]*, Abdolmohammad Ranjbar[1], Sonia Sharifi Namin[1], Homayoun Sadeghi-Bazargani[1]

[1]*Department of Cardiology, Tabriz University of Medical Sciences, Tabriz, Iran*

***Corresponding author:** *Babak Kazemi*
Address: Department of Cardiology, Tabriz University of Medical Sciences, Tabriz, Iran
e-mail: babak.kazemi1395@gmail.com

Received: June 10, 2016
Revised: August 27, 2016
Accepted: September 21, 2016

ABSTRACT

Objective: To determine the type and pattern of arrhythmic events following the 2012 Ahar-Varzegan Earthquake among patients implanted with cardiac defibrillators (ICDs) in East Azarbaijan province.
Methods: In a prospective cohort study, conducted in East Azerbaijan Province of Iran, 132 patients were enrolled in two comparison groups according to the region of residence i.e., earthquake region (n=98) and non-earthquake (n=34) region in 2012. Data were collected for those meeting standard criteria for sustained ventricular arrhythmias (VAs), or supraventricular tachycardias (SVTs) and triggered ICD therapies, either shock or anti-tachycardia pacing (ATP). The state version of the State-Trait Anxiety Inventory (STAI-S) was used to assess general symptoms of anxiety in both groups.
Results: Males comprised 81.1% of the participants. Mean age of the participants was 59.7±15 years. The frequency of patients with sustained VAs increased significantly after the earthquake (p=0.008). There were more VAs (mean 2.16 vs. 6.23; p=0.008) and they occurred earlier (6^{th} vs. 16^{th} day; p=0.01) in the earthquake area. The mean frequency of SVTs and the total number of delivered ICD therapies were similar between groups. Differences in anxiety levels were not significant between groups but there was a trend for presence of greater number of patients with anxiety (p=0.07) and the relative severity of anxiety (p=0.08) in the earthquake area.
Conclusion: In the earthquake area, the mean frequency of VAs increased and they occurred earlier in the earthquake area. The stress of anxiety might have served as a trigger for these events.

Keywords: Earthquake; Anxiety; Ventricular arrhythmias; Implantable defibrillators.

Please cite this paper as:
Ranjbar F, Akbarzadeh F, Kazemi B, Ranjbar A, Sharifi Namin S, Sadeghi-Bazargani H. Increased Likelihood of Arrhythmic Events Associated with Increased Anxiety in Patients with Implanted Cardiac Defibrillators after the Ahar-Varzegan Earthquake in East Azarbaijan, 2012. *Bull Emerg Trauma*. 2016;4(4):202-210.

Introduction

On the late afternoon of Saturday August 11, 2012 the North-West of Iran was shaken by two of the strongest earthquakes in Iranian history called as Ahar-Varzegan earthquakes. The first was hit by 6.4 Mw (moment magnitude scale) at 16:54 local time (12:23 GMT), and about 11 minutes later,

the second one by a 6.3 Mw struck 10 km to the west. Both earthquakes were completely felt in Tabriz, the capital of East Azarbaijan province, about 80 kilometers west to the epicenter of the event. Preliminary estimates showed more than 330 fatalities and the number of injured victims reached around 26,000. Overall, more than 50,000 people were resettled due to this catastrophe. As many as 365 villages, out of a total of 537 in the affected area, were heavily damaged (from 50% to 90%) and 46 villages were completely devastated [1]. To make the situation worse, the region experienced more than 250 moderate (3-4 Mw) and over 400 small (2.5-3 Mw) aftershocks during the first year after the incident [2]. Altogether, these imposed significant and unremitting physical and psychological stress among the residing population, both of which have been implicated as possible triggers for major ventricular arrhythmias (VAs) in patients with pre-existing cardiac disease [3-5].

Although, there is little doubt on increased cardiovascular risk after earthquakes, the underlying mechanism for this risk is unclear. Given the drastic conditions surrounding a major earthquake, it is difficult to conduct comprehensive experimental or epidemiological studies. Thus, it is not known how much of the risk is caused directly by the emotional trauma compared to consequences of the humanitarian as well as environmental issues surrounding the catastrophe.

Very few studies are available on arrhythmia incidence before and after a natural disaster in patients with implanted cardiac defibrillators (ICD) [6-9]. ICDs provide an exclusive opportunity to evaluate the effects of stress on arrhythmogenesis and are potentially a unique epidemiologic tool. Accordingly, the authors applied this technology to study the type and pattern of arrhythmic events following the 2012 Earthquake among patients implanted with ICDs in East Azarbaijan Province. We also measured the anxiety and its level in this clinical population to assess its association with the incidence of VAs.

Materials and Methods

Study Population

Study was conducted after an earthquake cluster in East Azerbaijan, North-West of Iran, in 2012. Through a comparative cross-sectional observational study and based on our cardiology department database there were 185 patients who were implanted single, dual and tri-chamber ICDs by standard indications. One hundred and thirty-two patients who had undergone ICD implantation before the earthquake were available for study. By reviewing the hospital files, the names and addresses of all patients were extracted. Patients were divided into two groups according to their region of residence: 1) the earthquake area (Varzaghan, Kalibar, Ahar and Tabriz) at a distance of 100 kilometers from the epicenter of the earthquake where the shaking by the earthquake was clearly felt; 2) the non-earthquake area comprised of patients of other cities of East Azarbaijan (areas with no or week sense of earthquake). Study started 7 months after the incident and patients were invited by telephone to take part in the survey. The study was approved by the Medical Ethics Committees of Tabriz University of Medical Sciences and all patients provided written informed consent. Demographics and clinical data for each patient were obtained from the clinic charts. Comprehensive ICD interrogation for each patient was done by electrophysiologysts who were blinded to the living areas of patients. The date and time of each tachyarrhythmia that triggered ICD therapy, either shock or anti-tachycardia pacing (ATP) and their frequencies were recorded. An arrhythmia requiring>1 shock/ATP for termination was counted as a single shock/ATP event. The electrogram stored in the device for each arrhythmic event was carefully scrutinized, and only those meeting standard criteria for sustained ventricular tachycardia, ventricular fibrillation (collectively named ventricular arrhythmias or VAs), or sustained supraventricular tachycardia (SVT) were included [10]. Non-sustained arrhythmias which didn't trigger the devices were not included. Devices were all from three major manufactures: Medtronic, St. Jude, and Boston Scientific companies. Inappropriate diagnosis of tachycardia by device (VAs and SVTs) and inappropriate therapies were corrected and categorized in the appropriate groups by electrophysiologysts. Average daily occurrences of arrhythmias before or after the earthquake were calculated as: total numbers of arrhythmias / time (duration in days before or after earthquake) in each patient. As shown in Figure 1, patients who experienced any type of arrhythmia before or after the earthquake were selected for arrhythmia based analysis. In other words, patients who didn't experience any kind of arrhythmia before or after earthquake excluded from arrhythmia based analysis.

Psychological Measures

The state version of the State-Trait Anxiety Inventory (STAI-S) was used to assess general symptoms of anxiety, such as worries and concerns, and tension [10,11]. State anxiety is assumed to fluctuate over time, whereas trait anxiety is considered to be more stable. In the current study we only used STAI-S because we wanted to assess the presence of symptoms of anxiety at baseline and not anxiety as a stable trait. The STAI-S is a self-report questionnaire, consisting of two 10-item scales, measuring, respectively, the presence and absence of anxiety symptoms. Items are answered on a 4-point Likert scale ranging from 1 (not at all) to 4 (very much so), with total scores ranging from 20 to 80 (the score of 20 indicating no anxiety and higher

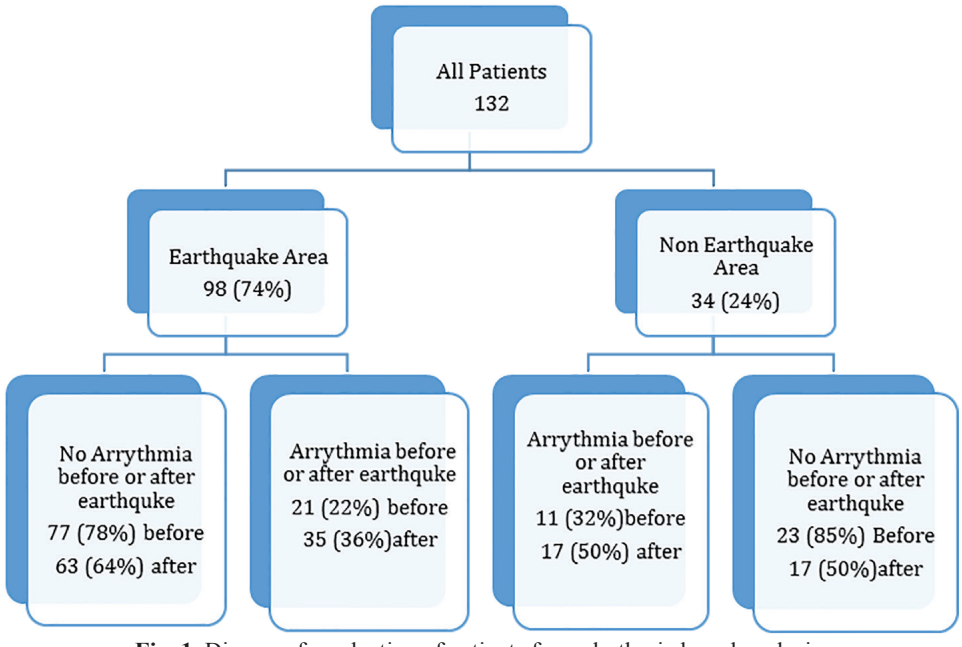

Fig. 1. Diagram for selection of patients for arrhythmia based analysis.

scores pointing to higher levels of anxiety). Based on STAI guides patients can be divided into five levels of anxiety: no anxiety-level I, low to moderate-level II, moderate to high-level III, relatively severe-level IV, and severe anxiety-level V). Patients were asked to fill the questionnaire and if they couldn't, a literate relative was allowed to help them. In cases which patients and relatives were unable to complete the task, a nurse who was blinded to the grouping of patients helped them in filling the questionnaire. A cut-off score ≥40 indicates probable clinical levels of anxiety [10,11]. The STAI-S has shown to be a valid and reliable measure, with Cronbach's alpha ranging from 0.87 to 0.92 [10]. In a previous study the validity and reliability of the translated STAI questionnaire has been confirmed in the Iranian population [12]. The STAI-S was administered at the end of follow-up of the study.

Statistical Analysis

Data entry and statistical analysis were done by SPSS version 19 statistical software package for windows. Categorical variables were analyzed reporting the frequencies and differences in frequency distribution among the groups were examined by Chi-square and McNemar's test. Numeric data were reported as mean±SD in normally distributed variables. In not normally distributed variables numeric data were reported as mean±SD, and the median was reported as additional information. Differences between mean of normally distributed variables were evaluated by student T-test and ANOVA test. In variables with skewed distribution, differences between independent numeric variables were evaluated by non- parametric Mann-Whitney U test. Differences between related measurements before and after earthquake date were examined by non-parametric Wilcoxon signed Rank test. A p value less than 0.05 was considered as statistically significant.

Results

All ICDs were implanted in 185 patients between 29 to 2774 days before the index earthquake. Nine patients were not available for the study due to loss of contact information (6 from earthquake and 3 from non earthquake area). Forty-four patients died before starting of the study, 35 patients before the earthquake (27 patients from earthquake area and 8 patients from non-earthquake area) and 9 patients after the earthquake (7 from earthquake area and 2 from non- earthquake area). We were unable to determine the exact cause of mortality in the study since the call information was not considered reliable for this matter. Finally, 132 patients were included for analysis. The clinical characteristics of the patients are shown in Table 1. All patients were on optimal medical therapy and the two groups were well matched, except for a longer duration for ICD implantation and longer follow-up in patients in the non-earthquake area.

Ventricular Arrhythmias

The frequency of patients who experienced sustained VAs significantly increased after the earthquake. Thirty-two patients (24.2%) experienced VA before the earthquake which increased to 52 patients (39.4%) after it (p=0.008). New cases of VA after earthquake occurred in 31 patients (22 patients in the earthquake area and 9 patients in the non-earthquake area (p=0.63). On the other hand, 9 patients (7 in the earthquake area and 2 in the non-earthquake area) who had episodes of VA before the earthquake didn't experience VA episodes after it (p=0.88). Data from patients with VA before or after the earthquake were separated from the entire

Table 1. Baseline characteristics of patients

Baseline characteristics	EQ[a] area (n=98)	Non-EQ[a] area (n=34)	Total (n=132)	*p* alue between areas
Male sex (n, %)	81 (82.6)	26 (76.4)	107 (81.1)	0.1
Age (years±SD)	60±14	58±16	59±15	0.5
Sinus rhythm after EQ[a] (n, %)	88 (89.7)	31 (91.1)	119 (90.2)	0.9
Sinus rhythm at implant (n, %)	84 (85.7)	30 (88.2)	114 (86.4)	0.9
ICM[b] (n, %)	78 (79.5)	26 (76.4)	104 (78.8)	0.7
DCM[c] (n, %)	20 (20.4)	8 (23.5)	28 (21.2)	0.7
ICD-VR[d] (n,%)	19 (19.3)	11(32.3)	30 (22.7)	0.1
ICD-DR[e] (n, %)	40 (40.8)	14 (41.1)	45 (40.9)	0.9
CRT-D (n, %)	39 (39.7)	9 (26.4)	48 (36.4)	0.1
LBBB[f] (n, %)	32 (32.6)	11 (32.3)	43 (32.6)	0.9
RBBB[g] (n, %)	12 (12.2)	3 (8)	14 (11.4)	0.8
Nonspecific IVCD[h] (n, %)	6 (6.1)	4 (1.1)	10 (7.6)	0.3
MR[i] (moderate) (n, %)	12 (12.2)	6 (16)	18 (14.3)	0.9
MR[i] (severe) (n, %)	6 (6.1)	5 (14.7)	11 (8.7)	0.2
Previous infarction (n, %)	40 (40.8)	15 (44.1)	55 (41.7)	0.7
LVEF[j] (%±SD)	28.8±11.2	28±12.9	26.8±11.6	0.9
CRF[k] (n, %)	14 (14.2)	4 (11.7)0.9	18 (13.6)	0.9
Creatinine (mg/dl±SD)	1.23±0.98	0.97±0.27	1.16±0.84	0.1
Hypertension (n, %)	46 (46.9)	16 (47)	62 (47)	0.9
Dyslypidemia (n, %)	30 (30.6)	11 (32.3)	41 (31.4)	0.8
Smoking (n, %)	27 (27.5)	12 (35.2)	39 (29.5)	0.3
Time from implant to occurrence of EQ[a] (days±SD)	658±519	1112±662	805±592	0.01
Follow up after EQ[a] (days±SD)	310±54	335±47	317±54	0.01
Anxious (STAI[l]-score ≥ 40) (n, %)	29 (29.5)	15 (44.1)	44 (33.3)	0.07

[a]EQ: Earthquake; [b]ICM: Ischemic Cardiomyopathy; [d]DCM: Dilated Cardiomyopathy; ICD-VR: Single Chamber ICD; [e]ICD-DR: Dual Chamber ICD; [f]LBBB: Left Bundle Branch Block; [g]RBBB: Right Bundle Branch Block; [h]IVCD: Interventricular Conduction Delay; [i]MR: Mitral Regurgitation; [j]LVEF: Left Ventricular Ejection Fraction; [k]CRF: Chronic Renal Failure; [l]STAI: State Trait Anxiety Inventory.

data and further statistical analyses were performed (Figure 1). In the earthquake area the mean frequency of total VA was 2.16±0.63 (median=0.5) before the earthquake which increased to 6.23±1.71 (median=2.0) after that (p=0.008). These numbers were 4.57±1.68 (median=2.0) and 12.94±7.90 (median=3.0) respectively in patients from the non-earthquake area (p=0.61). Because of differences between implant time before the earthquake and follow up time after it, these numbers were corrected by duration of implantation before and after the earthquake. Therefore, the mean VA per day was calculated by dividing sum of sustained VAs in each patient to the duration of implantation before and at follow-up (by days) after the earthquake. Because of the long duration of implant before and at follow up time after the earthquake the calculated numbers were very small, therefore the results were multiplied by 1000 for better clarification (Table 2). The median time to occurrence of first episode of sustained VA was 32 days (6-389 days) in the earthquake area and 122 days (16-344 days) in the non-earthquake area (p=0.001). Kaplan Mayer curve of time to first episode of VA in two groups are shown in Figure 2. The first occurrence of VA was day 6 in the earthquake area and day 16 in the non-earthquake area (p=0.01). As this Figure shows patients in the earthquake area experienced significantly more VA up to about 8 months after the incident.

Supraventricular Arrhythmias

The frequency of patients who experienced SVTs was not different before and after the earthquake (p=0.6). Twenty-two patients (16.7%) and 25 patients (18.9%) experienced SVTs before and after the earthquake, respectively (p=0.30). New episodes of SVT occurred in 13 patients after the earthquake (11 in the earthquake area and 2 in the non-earthquake area; p=0.57). On the other hand, 10 patients who had episodes of SVT before the earthquake did not experience any SVT after it (7 in earthquake area and 3 in non-earthquake area; p=0.95). The mean average of SVT episodes in patients within the earthquake area was 7.92±2.65 (median=1.0) before the earthquake which increased to 14.5±3.73 (median=7.5) after that (p=0.37). These numbers were 5.33±2.84 and 18.44±7.97 in the non-earthquake area patients (p=0.23). Because of the long duration of implant before and at follow-up time after the earthquake, the calculated numbers were very small, so the sustained SVT per day was calculated by the same method as sustained VA per day (Table 2).

Table 2. Differences between arrhythmia episodes before and after earthquake among patients in earthquake versus non earthquake areas

Arrhythmias	EQ[a] area (n=98)	Non-EQ[a] area (n=34)	Total (n=132)	*p* value between areas
SVT before EQ[a] (n, %)	15 (15.3)	7 (20.6)	22 (16.7)	0.35
SVT after EQ[a] (n, %)	19 (19.4)	6 (17.6)	25 (18.9)	0.52
***p* value before and after in each group**	0.4	0.7	0.6	
VT/VF[b] before EQ[a] (n, %)	21 (21.4)	11 (32.4)	32 (24.2)	0.13
VT/VF[b] after EQ[a] (n, %)	35 (35.7)	17 (50.0)	52 (39.4)	0.16
***p* value**	0.02	0.1	0.008	
	Mean±SEM Median	Mean±SEM Median	Mean±SEM Median	
SVT[c] per day before EQ[a]/1000	10.62±4.29 0.46	2.76±1.07 1.63	8.72±3.29 1.11	0.83
SVT[c] per day after EQ[a]/1000	50.72±15.11 27.85	51.01±20.97 7.38	50.80±12.30 19.73	0.92
***p* value before and after in each group**	0.009	0.06	0.002	
VT/VF[b] per day before EQ[a] /1000	3.25±1.61 0.001	2.97±1.00 1.16	3.14±1.04 0.001	0.08
VT/VF[b] per day after EQ[a] /1000	20.97±9.68 5.28	5.72±2.60 3.04	15.04±6.07 3.4	0.16
***p* value before and after in each group**	0.02	0.59		

[a]EQ: Earthquake; [b]VT/VF: Ventricular Tachycardia/Fibrillation; [c]SVT: supraventricular tachycardia.

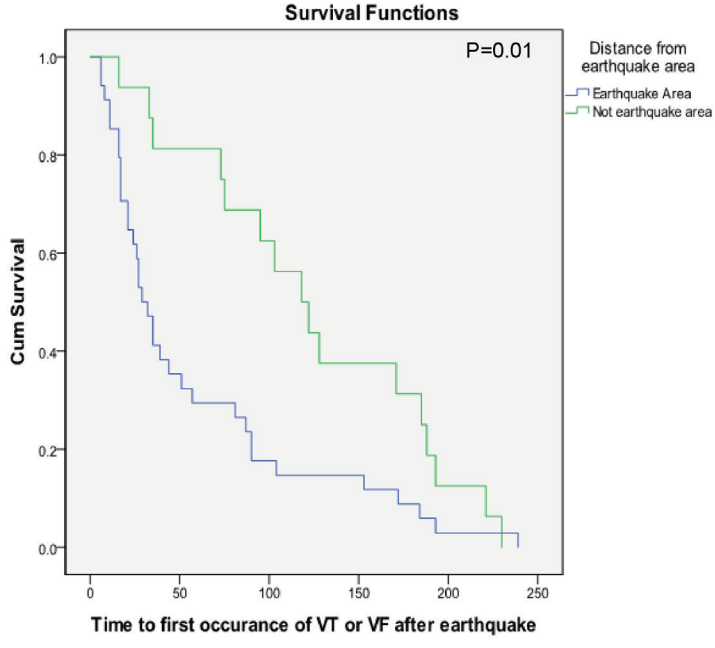

Fig. 2. Kaplan-Mayer curve of time to first episode of ventricular arrhythmia.

Frequency and type of therapies delivered by the devices before and after the earthquake strike are shown in Table 3. Although there were more VAs, but the frequency of delivered ICD therapies (ATP and shocks) per each episode of arrhythmia did not differ between groups.

Anxiety Evaluation

Two illiterate and poorly cooperated patients from the earthquake area were excluded from the study, with one experiencing a sustained VA. Data from the rest of 130 patients were included and analyzed. Sixty-eight patients filled the questionnaire by themselves, 39 were helped by their relatives, and in 23 patients the questionnaire was filled by the research nurse. The numbers of patients with each level of anxiety in earthquake and non earthquake area are shown in Figure 3. We did not have any patient in both groups with no anxiety. Differences in anxiety levels were not significant between patients in earthquake area vs. non-earthquake area but as shown in both Table 1 and Figure 3, there was a trend for a statistically

Table 3. Frequency and type of therapies delivered for treatment of VT/VF before and after earthquake in patients living in earthquake versus non-earthquake areas

	EQ[a] Area Mean±SD	Non-EQ[a] area Mean±SD	Total Mean±SD	*p* value between areas
Number of therapy per each VT/VF[b] before EQ[a]	1.10±0.10	1.07±0.05	1.08±0.05	0.85
Number of therapies per each VT/VF[b] after EQ[a]	1.51±0.11	1.45±0.16	1.49±0.09	0.57
***p* value before and after in each group**	0.65	0.08	0.23	
ATP[c]/Shock therapy for VT/VF[b] before EQ[*] (%)	79.16±13.99	76.22±6.32	77.61±7.14	0.34
ATP[c]/Shock therapy for VT/VF[b] after EQ[*] (%)	60.65±9.62	63.65±13.88	61.94±7.8	0.65
***p* value before and after in each group**	0.78	0.11	0.15	

[a]EQ: Earthquake; [b]VT/VF: Ventricular Tachycardia/Fibrillation; [c]ATP: Anti-Tachycardia Pacing.

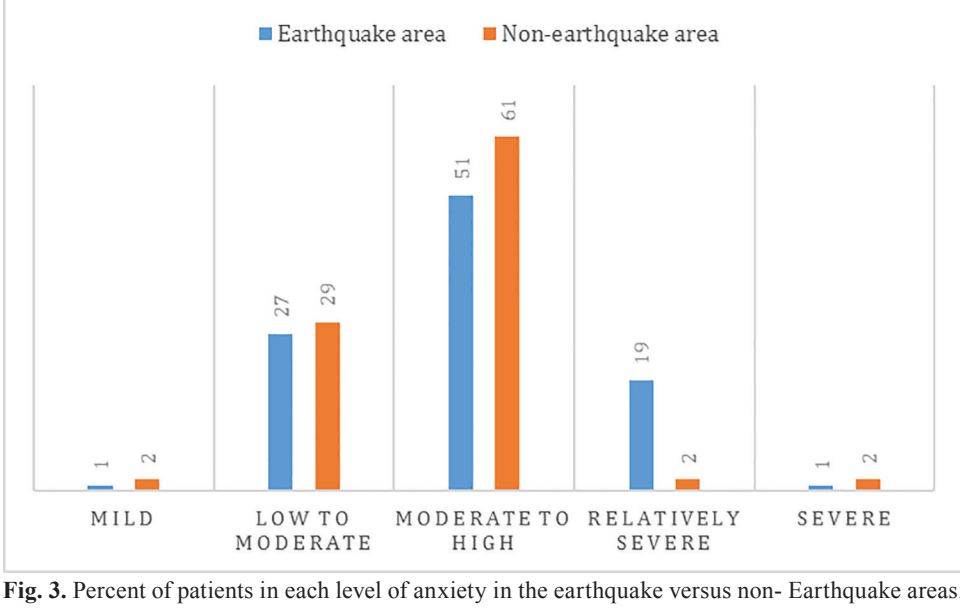

Fig. 3. Percent of patients in each level of anxiety in the earthquake versus non- Earthquake areas.

significant presence (p=0.07) of more patients with anxiety (based on a cutoff score≥40 on the STAI-S questionnaire) and the relative severity of anxiety (p=0.08) in the earthquake area. The relation of time to occurrence of the first episode of VA and the anxiety level of patients in both groups are showed in Table 4. Although the absolute number of patients with each level of anxiety experiencing VA was higher in the earthquake area, the relation did not reach statistical significance. Twelve out of 25 patients (48%) with high grades of anxiety (grades III to IV) in the Earthquake area experienced their first episode of VA during 30 days after index event but no patient from 11 patients in the non earthquake area experienced VAs during that period (Table 4).

Discussion

This study evaluated the frequency and severity of arrhythmia episodes after the 2012 East Azarbaijan Earthquake and their relation to the imposed psychological stress by that event. The main findings are that the frequency of VAs was increased both in the earthquake and non-earthquake areas but it occurred more frequently and earlier in the former. These differences faded about 8 months after the earthquake due to continuation of numerous aftershocks during this period in the region. Although there were more VAs, but the frequency of delivered ICD therapies (ATP and shocks) did not differ between groups. This might indicate that the severity of ventricular events was the same and only their frequency was increased. The mean frequencies of SVTs were also similar between groups. Differences in anxiety levels were not significant between groups but there was a trend for presence of more patients with anxiety and the relative severity of anxiety in the earthquake area. Although the absolute number of patients with each level of anxiety experiencing VA was higher in the earthquake area, the relation did not reach statistical significance, most probably due to small number of patients.

The findings of our study are along with other

Table 4. Frequency of patients in each level of anxiety based on time to occurrence of first episode of sustained ventricular arrhythmia in Earthquake versus non Earthquake area

Time to occurrence of first sustained VT/VF	Area	STAI Anxiety level				Total (each area each period)
		II	III	IV	V	
Less than 30 days	EQ	4 (25)	7 (43.8)	4 (25)	1 (6.3)	16
	NEQ	1 (100)	0	0	0	1
	p value	0.64	0.85	0.52	0.05	
Less than 60 days	EQ	7 (30.4)	10 (43.5)	5 (21.7)	1 (4.3)	23
	NEQ	1 (33.3)	2 (66.7)	0	0	3
	p value	0.57	0.88	0.90	0.21	
Less than 90 days	EQ	8 (32)	11 (44)	5 (20)	1 (4)	25
	NEQ	1 (20)	4 (80)	0	0	5
	p value	1.0	0.32	0.66	0.32	
Less than 120 days	EQ	8 (28.6)	13 (46.4)	6 (21.4)	1 (3.6)	28
	NEQ	2 (25)	6 (75)	0	0	8
	p value	0.80	0.30	0.31	0.54	
Less than 150 days	EQ	8 (28.6)	13 (46.4)	6 (21.7)	1 (3.6)	28
	NEQ	2 (20)	8 (80)	0	0	10
	p value	0.91	0.14	0.37	0.49	
Less than 180 days	EQ	8 (25.7)	15 (50)	6 (20)	1 (3.3)	30
	NEQ	2 (18.2)	8 (72.7)	1 (9.1)	0	11
	p value	0.88	0.002	0.72	0.59	
Total follow up	EQ	9 (26.5)	18 (52.9)	6 (17.6)	1 (2)	34
	NEQ	6 (35.3)	10 (58.8)	1 (5.9)	0	17
	p value	0.74	0.92	0.47	0.72	

studies which showed the role of emotional stress on triggering of cardiac events [3-5]. Currently there is a general agreement on the role of acute stress in triggering cardiac events, especially in patients with underlying cardiovascular diseases [13]. The consequences of an acute and unexpected stressor have been studied during earthquakes, providing a population-based sampling methodology, the known exact timing of the stressor, and tabulation of acute cardiac events before and after the event. All these studies have shown a direct relation between earthquakes and cardiovascular deaths [14], incidence of acute myocardial infarction and its mortality [15,16], stroke [17,18], and heart failure [18]. Although it was impossible to evaluate anxiety level of patients frequently after earthquake but our study showed 48% of patients with higher grades of anxiety experienced VAs during 30 days after event in earthquake area. No patient with greater than grade II anxiety in non earthquake area experienced VAs in this period of time. Based on continuation of earthquake aftershocks, it can be assumed that the effects of stressors on cardiac arrhythmias appear during early phases after the event.

Anxiety and concerns about the device have been studied repeatedly in ICD patients [19-21]. Although the majority of patients tend to adjust well to living with an ICD, one quarter to around half of patient's experience difficulty with adjustment and clinical anxiety and depression [19,20]. Anxiety and general psychological distress in ICD patients may have adverse effects on health outcomes, with both physical and psychological stressors precipitating arrhythmic events [3-5,22]. The overall frequency of anxiety and depression has been reported to be 20% in patients with ICDs [23]. The frequency of all levels of anxiety in all our patients was about 33%. The difference may be due to using a different type of questionnaire in our study. On the other hand we evaluated the effect of acute stress not the chronic anxiety. Based on our data the overall frequency of patients with severe forms of anxiety was not different between groups but the patients with ventricular arrhythmias in earthquake area especially in the 1st month after earthquake experienced severe forms of anxiety.

Chi *et al*., [24] investigated whether the terrorist attacks of September 11, 2001, were associated with increased cardiac mortality in New York City by analyzing death certificate data around that period. Their conclusion was that no disproportionate increase in cardiovascular mortality occurred after the attacks. This form of analysis, using death certificates, is largely inaccurate in evaluation of the cause of death and may make it insensitive for evaluating specific arrhythmic events. On the other hand, due to recall ability of ICDs (they can store all arrhythmic events after implantation and these events can be reviewed at any time), they can be used to study the precise incidence, nature, and timing of VAs both before and during acute stressful events transforming them to a potentially unique epidemiologic tool. Only few studies are available on arrhythmia incidence before and after a natural disaster in patients with ICDs [6-9].

Nishimoto *et al.* [6] were first to detect an increase in the number of episodes of VAs among patients

with ICD during the two weeks after the Northridge earthquake. Steinberg and Shedd *et al*., [7,8] suggested a specific increase in the number of VAs in ICD patients in the weeks following the World Trade Center attack of September 11, 2001, both in patients living near or geographically distant from New York City. Nakano *et al*., [9] demonstrated the clinical impact of the East Japan Earthquake on patients implanted with ICDs. Similar to our results, they found that although defibrillator shocks were not increased, the device recordings clearly showed a significant increase in tachyarrhythmias after the Earthquake. Again, this increase was sustained for a few months after the earthquake possibly due the effect of aftershocks on quality of life and physical/mental stress of subjects residing in the affected area, or probably in a complex way by the consequences of the humanitarian catastrophe: the trauma, breakdown of lifelines (water, food, electricity, traffic, the emergency system), evacuation, and etc. Also similar to our study, the mean frequency of SVTs was comparable between groups, either because undistinguishable tachyarrhythmias were recognized by the single-chamber device as ventricular in origin or because of a relatively small number of patients.

In none of the above studies, anxiety as a marker of psychological stress was measured. Our study is the first to measure anxiety and its level for confirming its relation to increased incidence of VAs in patients with ICDs. Although the absolute number of patients with each level of anxiety experiencing VA was higher in the earthquake area, unfortunately the relation did not reach statistical significance, probably because of a relatively small sample size.

Our results, like others, strengthen the hypothetic relation between acute stress and increased arrhythmogenesis among patients with underling cardiac disease. A primary prevention strategy is needed to treat this population, by identifying those at highest risk for event-related arrhythmias which will allow for targeted psychological intervention [8]. On the other hand, a public health strategy should coordinate a planned response to cardiac arrhythmias and involve emergency care, media, and personal and familial strategies to ensure the safety and efficacy of care for at-risk persons [8].

Several limitations of the present study should be mentioned. First, it is retrospective and observational in design, which for studying a rare disaster is inevitable. Second, sample size was relatively small. Third, because our study was limited to an ICD population, we cannot readily extrapolate our findings to a broader spectrum of cardiac patients. And finally, recall bias is one of important issues about case-control studies. In the arrhythmic limb of study it was not a concern because of the existence of ICDs but on the matter of anxiety evaluation it can be potentially an issue. We implemented methodological strategies documented in the literature to minimize recall bias [25]. Furthermore, because of continuation of numerous aftershocks after the earthquake, conducting the study about 7 months after the event, and evaluation of last patient 56 days after termination of aftershocks, the effect of this limitation was further curtailed. On the other hand, the reliability of the translated form of the STAI-S questionnaire was more than 70% for Iranian people up to 106 days after a stressful event [12].

In conclusion, the mean frequency of VAs increased and they occurred earlier in the earthquake area. The stress of anxiety might have served as a trigger for these events. We trust that these results will contribute to the improvement of emergency medical care in similar situations in the future. These results may have implications for helping disaster relief workers identify potentially vulnerable individuals and tailor interventions and relief efforts for these individuals.

Acknowledgment

This article was written based on a dataset of specialty in cardiology thesis (approval number: 91/12/8-5/4/11489), registered in Tabriz University of Medical Sciences.

Funding

The study was funded by the Cardiovascular Research Center, Tabriz University of Medical Sciences. We affirm not having entered into an agreement with the funder that may have limited our ability to complete the research as planned, and we have had full control of all primary data.

Conflict of Interest: None declared.

References

1. Miyajima M, Fallahi A, Sadeghi A, Ghanbari E, Soltani H, Amiraslanzadeh R, et al. Site Investigation of the Ahar-Varzeghan Earthquake in NW Iran of August 11, 2012. Retreived from http://committees. jsce. or. jp/disaster/taxonomy/term/33. Fact Sheet: FS2013-E-0001. 2012:1-8.
2. Amini Hosseini K, Hosseinioon S, Pooyan Z. An investigation into the socioeconomic aspects of two major earthquakes in Iran. Disasters. 2013;37(3):516-35.
3. Fries R, Konig J, Schafers HJ, Bohm M. Triggering effect of physical and mental stress on spontaneous ventricular tachyarrhythmias in patients with implantable cardioverter-defibrillators. *Clin Cardiol*. 2002;**25**(10):474-8.
4. Lampert R, Joska T, Burg MM, Batsford WP, McPherson CA, Jain D. Emotional and physical precipitants of ventricular arrhythmia. *Circulation*. 2002;**106**(14):1800-5.
5. Dunbar SB, Kimble LP, Jenkins LS, Hawthorne M, Dudley W, Slemmons M, et al. Association of mood disturbance and arrhythmia

events in patients after cardioverter defibrillator implantation. *Depress Anxiety*. 1999;**9**(4):163-8.

6. Nishimoto Y, Firth B, Kloner R, Leor J, Lerman R, Bhandari A, et al., editors. The 1994 northridge earthquake triggered shocks from implantable cardioverter-defibrillators. Circulation; 1995: Amer Heart Assoc 7272 Greenville Avenue, Dallas, TX 75231-4596.

7. Steinberg JS, Arshad A, Kowalski M, Kukar A, Suma V, Vloka M, et al. Increased incidence of life-threatening ventricular arrhythmias in implantable defibrillator patients after the World Trade Center attack. *J Am Coll Cardiol*. 2004;**44**(6):1261-4.

8. Shedd OL, Sears SF, Jr., Harvill JL, Arshad A, Conti JB, Steinberg JS, et al. The World Trade Center attack: increased frequency of defibrillator shocks for ventricular arrhythmias in patients living remotely from New York City. *J Am Coll Cardiol*. 2004;**44**(6):1265-7.

9. Nakano M, Kondo M, Wakayama Y, Kawana A, Hasebe Y, Shafee MA, et al. Increased incidence of tachyarrhythmias and heart failure hospitalization in patients with implanted cardiac devices after the great East Japan earthquake disaster. *Circ J*. 2012;**76**(5):1283-5.

10. Van der Ploeg H, Defares P. ZBV: a Dutch-language adaptation of the Spielberger state-trait anxiety inventory. Lisse, The Netherlands: Swets & Zeitlinger NedTPsychologie. 1980;35:243-9.

11. Spielberger CD. Manual for the State-Trait Anxiety Inventory. Palo Alto, CA: Consulting Psychologists Press Inc.; 1983.

12. Panahi-Shahri M. The primary study in validity, reliability and norms of the state-trait anxiety inventori (STAI) in Iranian student smaple (M.A. dissertation). Tehran: Tarbiyat Modares; 1993 p. 59-69. [Persian].

13. Tofler GH, Muller JE. Triggering of acute cardiovascular disease and potential preventive strategies. *Circulation*. 2006;**114**(17):1863-72.

14. Leor J, Poole WK, Kloner RA. Sudden cardiac death triggered by an earthquake. *N Engl J Med*. 1996;**334**(7):413-9.

15. Suzuki S, Sakamoto S, Miki T, Matsuo T. Hanshin-Awaji earthquake and acute myocardial infarction. *Lancet*. 1995;**345**(8955):981.

16. Nakagawa I, Nakamura K, Oyama M, Yamazaki O, Ishigami K, Tsuchiya Y, et al. Long-term effects of the Niigata-Chuetsu earthquake in Japan on acute myocardial infarction mortality: an analysis of death certificate data. *Heart*. 2009;**95**(24):2009-13.

17. Tsuchida M, Kawashiri M-a, Teramoto R, Takata M, Sakata K, Omi W, et al. Impact of severe earthquake on the occurrence of acute coronary syndrome and stroke in a rural area of Japan experience from the Noto Peninsula earthquake. *Circulation Journal*. 2009;**73**(7):1243-7.

18. Aoki T, Fukumoto Y, Yasuda S, Sakata Y, Ito K, Takahashi J, et al. The Great East Japan Earthquake Disaster and cardiovascular diseases. *Eur Heart J*. 2012;**33**(22):2796-803.

19. Ranjbar F, Akbarzadeh F, Ghaemian N. P01-300-The study on anxiety disorders in implantable cardioverter defibrillator (ICD) patients. *European Psychiatry*. 2010;**25**:513.

20. Sears SF, Jr., Conti JB. Quality of life and psychological functioning of icd patients. *Heart*. 2002;**87**(5):488-93.

21. Sears SF, Jr., Conti JB. Psychological aspects of cardiac devices and recalls in patients with implantable cardioverter defibrillators. *Am J Cardiol*. 2006;**98**(4):565-7.

22. Whang W, Albert CM, Sears SF, Jr., Lampert R, Conti JB, Wang PJ, et al. Depression as a predictor for appropriate shocks among patients with implantable cardioverter-defibrillators: results from the Triggers of Ventricular Arrhythmias (TOVA) study. *J Am Coll Cardiol*. 2005;**45**(7):1090-5.

23. Magyar-Russell G, Thombs BD, Cai JX, Baveja T, Kuhl EA, Singh PP, et al. The prevalence of anxiety and depression in adults with implantable cardioverter defibrillators: a systematic review. *J Psychosom Res*. 2011;**71**(4):223-31.

24. Chi JS, Poole WK, Kandefer SC, Kloner RA. Cardiovascular mortality in New York City after September 11, 2001. *Am J Cardiol*. 2003;**92**(7):857-61.

25. Hassan E. Recall bias can be a threat to retrospective and prospective research designs. *Interna J Epidemiol* 2006; 3 (2).