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RESEARCH

Impact of the earthquake disaster in Türkiye on the use of cardiac implantable electronic devices and clinical presentation of patients

Türkiye'deki deprem felaketinin kardiyak implante edilebilir elektronik cihazların kullanımı ve hasta kliniği üzerindeki etkisi

Oğuz Akkuş[1], Ramazan Yasdıbaş[1], Hülya Binokay[2]

[1]Mustafa Kemal University, Antakya, Turkiye
[2]Cukurova University, Adana, Turkiye,

Abstract

Purpose: The aim of this study is to investigate the effects of the earthquake on the indication for cardiac implantable electronic devices (CIED) and whether it had an effect on the hospitalization clinics of the patients in our cardiology clinic in Hatay province of Türkiye.
Materials and Methods: A total of 186 consecutive patients who underwent an CIED (CRT, ICD, VVIR/DDDR) implantation in our clinic in the 1-year period before (n=120) and after the earthquake (n=66) were retrospectively included in our study.
Results: CIED rates were similar between the pre- and post-earthquake groups. Cardiac devices were not implanted in our clinic during the first 3 months after the earthquake. The severity of coronary artery disease and the rates of previous interventional coronary procedures were similar between the pre- and post-earthquake groups. New York Heart Association (NYHA) class was significantly higher in the pre-earthquake group compared to the post-earthquake group (NYHA III-IV rates were 24.3% and 9.4%, respectively). Complication and mortality rates after CIED implantation before and after the earthquake were similar.
Conclusion: Although the devastating earthquake reduced the number of CIED implantations in our clinic, the rates were similar. Patient groups with decompensated heart failure findings were detected less frequently after the earthquake.
Keywords:. Emotional stress, earthquake, pacemaker, CIED.

Öz

Amaç: Bu çalışmanın amacı Hatay ilindeki kardiyoloji kliniğimizde depremin kardiyak implante edilebilir elektronik cihazlar (KİEC) endikasyonuna olan etkilerini ve hastaların hastane yatış klinikleri üzerinde bir etkisi olup olmadığının araştırılmasıdır.
Gereç ve Yöntem: Kliniğimizde depremden önce (n=120) ve depremden sonraki (n=66) 1'er yıllık süreçte KİEC (CRT, ICD, VVIR/DDDR) implantasyonu yapılan 186 hasta retrospektif olarak çalışmaya dahil edildi.
Bulgular: KİEC oranları deprem öncesi ve sonrası gruplar arasında benzerdi. Kliniğimizde depremden sonraki ilk 3 ay boyunca KİEC uygulanmadı. Koroner arter hastalığının şiddeti ve koroner girişim oranları deprem öncesi ve sonrası gruplar arasında benzerdi. NYHA sınıfı deprem öncesi grupta deprem sonrası gruba göre anlamlı derecede daha yüksekti (NYHA III-IV oranları sırasıyla %24,3 ve %9,4). Depremden önce ve sonra, KİEC implantasyonu sonrası komplikasyon ve ölüm oranları benzerdi.
Sonuç: Yıkıcı depremin etkisi olarak kliniğimizdeki KİEC implantasyon sayısı azalmış olsa da oranlar benzerdi. İleri dekompanse kalp yetmezliği bulguları olan hastalar depremden sonra daha az sıklıkta kliniğimize başvurdu.
Anahtar kelimeler: Emosyonel stres, deprem, kalp pili, KİEC.

Address for Correspondence: Oguz Akkus; Mustafa Kemal University, Faculty of Medicine, Department of Cardiology, Antakya, Turkiye, E-mail: oakkusfb@gmail.com
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INTRODUCTION

The massive earthquake that occurred in Turkiye on February 6, 2023 is a natural disaster that caused the death of thousands of people and the destruction of at least 11 provinces and their surrounding areas. Living conditions for survivors of this devastating earthquake have changed dramatically. After the earthquake, people living in the affected areas began to experience psychological and physical trauma, their living conditions deteriorated, transportation problems began to emerge and the result was emotional stress. Clinical deterioration caused by earthquakes has been demonstrated in post-earthquake studies[1]. The effect of the emotional stress created by the earthquake is mainly on the heart, which is the leading cause of mortality and morbidity. There may be changes in the frequency of myocardial infarction, heart failure, and related or directly caused arrhythmias after major earthquakes[2,3]. Cardiac implantable electronic devices (CIED); cardiac resynchronization therapy-biventricular pacemakers (CRT), implantable cardioverter–defibrillators (ICD) or bradycardia pacemakers (VVIR/ DDDR) are used for the treatment of heart diseases accompanied by potential rhythm disturbances (symptomatic bradycardia, heart blocks, heart failure, ventricular fibrillation/tachycardia etc.)[4].

Although there are many studies examining the effects of emotional and traumatic stress on the heart caused by the earthquake, there are no sufficient studies examining post-earthquake arrhythmic events and, moreover, whether the impact of the earthquake on patient clinical conditions has any impact on CIED usage rates. It was thought that the stress caused by the earthquake could lead to an increase in the incidence of arrhythmic events and thus the use of CIEDs. For this reason, we aimed to investigate the effects of the earthquake on the indication for CIED and whether it had an effect on the hospitalization clinics of the patients in our cardiology clinic in Hatay province, a region where the earthquake destroyed almost the entire city.

MATERIALS AND METHODS

Sample

A total of 186 consecutive patients who underwent a CIED (CRT, ICD, VVIR/ DDDR) implantation in our clinic in the 1-year period before (n=120) and after the earthquake (n=66) were retrospectively included in our study. Patient selection for the appropriate CIED was made according to patient clinical features (NYHA class, syncope, dizziness, palpitation complaints, etc.), electrocardiographic findings (heart rate, QRS morphology, presence or absence of heart block, etc.), echocardiographic findings (ejection fraction etc.), frailty, and survival expectation. Patients hospitalized with AV block, VT/VF, symptomatic bradycardia and rescue cardiac arrest were evaluated as the urgent group and appropriate CIED was applied. HFeEF and HFeRF+ broad QRS complex patients were evaluated as the non-urgent patient group and appropriate CIED was applied. Patients without a CIED, who were not hospitalized in the mentioned months, were excluded from the study. Since this is a retrospective study, patient consent forms were not obtained in our study.

Procedure

The study was conducted at Mustafa Kemal University Cardiology Clinic. Ethics committee approval of the study was received by the Mustafa Kemal University Non-invasive Ethics Committee on August 06, 2024 (decision number: 46/3). It was conducted retrospectively by reviewing the records of the physicians working in the hospital before and after the earthquake.

Functional capacity of patients

New York Heart Association classification (NYHA) was used to assess the functional status and clinical severity of the patients. It is classified as asymptomatic (NYHA 1), mildly symptomatic (NYHA II), severely symptomatic with mild exertion (NYHA III), and symptomatic even at rest (NYHA IV)[5].

Implantable cardiac devices

Bradycardia pacemakers are used in sick sinus syndrome, advanced, 2nd and 3rd degree heart blocks. Single chamber ventricular (in case of atrial fibrillation) or dual chamber pacing modes are available[6]. Biventricular pacemakers are used in patients who are symptomatic (NYHA class 2 or higher), low LVEF (35% or less left ventricular ejection fraction), left bundle branch block (QRS duration of 130 ms or longer), or have a QRS duration of 150 ms or longer without left bundle branch block, despite optimal medical therapy[4]. Sudden cardiac death is the most common cause of death worldwide and ICD is a CIED recommended for this purpose. ICD has been used in patients presenting with sustained ventricular tachycardia, rescue cardiac arrest and/or heart failure with an EF of 35% and below[7].

Statistical analysis

Chi-square test was used to compare categorical variables between the groups. For the comparison of continuous variables between two groups, the Student's t-test or Mann-Whitney U test was used depending on whether the statistical hypotheses were fulfilled or not. Categorical variables were expressed as numbers and percentages, continuous variables were summarized as mean and standard deviation. In univariate analysis, variables significant at the $p<0.10$ level were included in logistic regression analysis. Logistic regression analysis was performed to determine the risk factors for the group variable and obtain the adjusted odds ratios (ORs) for the age and gender variables. All analyses were performed using IBM SPSS Statistics Version 20.0 statistical software package (IBM Corp. Released 2011. IBM SPSS Statistics for Windows, Version 20.0 Armonk, NY: IBM Corp.). The statistical level of significance for all tests was considered to be 0.05.

RESULTS

Table 1 shows clinical and laboratory parameters between pre- and after-earthquake groups. Although general demographic parameters (age, gender, diabetes, hypertension etc.) were similar before and after the earthquake ($p>0.05$), the use of some medications; angiotensin-converting enzyme inhibitor/angiotensin receptor blocker (ACEI/ARB), antiplatelet therapies were found to be significantly higher in the pre-earthquake group ($p<0.05$). The severity of coronary artery disease and the number of previous interventional coronary procedures were similar between the pre-and post-earthquake groups.

Table 1. Comparison of clinical and laboratory characteristics between pre- and after-earthquake groups.

Variable	Group 1 (n=120) χ ± SS/n (%)	Group 2 (n=66) χ ± SS/n (%)	p
Gender			
Male	83(69.2)	42(63.6)	0.442
Female	83(69.2)	24 (36.4)	
DM			
Absent	63(52.9)	40(61.5)	0.261
Present	56(47.1)	25(38.5)	
HT			
Absent	47(39.5)	27(42.9)	0.661
Present	72(60.5)	36(57.1)	
Mitral valve regurgitation			
None	6(7.9)	16 (33.3)	0.001
Mild Moderate/	45(59.2)	17(35.4)	
Severe	25(32.9)	15(31.3)	
Aortic valve regurgitation			
None	18(46.2)	30(81.1)	0.002
Mild/Moderate	21(53.8)	7(18.9)	
MI			
Absent	72(60.5)	32(49.2)	0.140
Present	47(39.5)	33(50.8)	
PCI			
Absent	70(58.3)	43(66.2)	0.298
Present	50(41.7)	22(33.8)	
CABG			
Absent	102(85.0)	52(78.8)	0.283
Present	18(15.0)	14(21.2)	

Atrial fibrillation			0.572
Absent	97(83.6)	53(80.3)	
Present	19(16.4)	13(19.7)	
B-blocker			
Absent	37(31.1)	25(37.9)	0.349
Present	82(68.9)	41(62.1)	
CCB			
Absent	101(85.6)	55(83.3)	0.682
Present	17(14.4)	11(16.7)	
ACEI/ARB			
Absent	34(28.3)	37(56.1)	<0.001
Present	86(71.7)	29(43.9)	
MRA			
Absent	62(51.7)	43(65.2)	0.076
Present	58(48.3)	23(34.8)	
Anticoagulation			
None	95(79.2)	54(81.8)	
Warfarin	10(8.3)	1 (1.5)	0.096
NOAC	15(12.5)	11(16.7)	
Oral anti-diabetic agent			
Absent	74(61.7)	42(63.6)	0.791
Present	46(38.3)	24(36.4)	
Insulin			
Absent	104 (86.7)	62 (95.4)	0.062
Present	16(13.3)	3(4.6)	
Coronary stenosis			
<50%	96(80.0)	45(69.2)	0.101
>50%	24(20.0)	20(30.8)	
CIED			
VVIR-ICD	32(26.7)	26(39.4)	
DDDR-ICD	13(10.8)	6(9.1)	
VVIR-PACEMAKER	6(5.0)	6 (9.1)	
DDDR-PACEMAKER	43(35.8)	17(25.8)	0.261
CRT-D	26(21.7)	11(16.7)	
Complication			
Absent	42(75.0)	35(77.8)	0.744
Present	14 (25.0)	10 (22.2)	
Post-discharge mortality (1 year)			
Absent	75 (80.6)	36 (83.7)	0.667
Present	18 (19.4)	7 (16.3)	
Antiplatelet agent			
None	40 (33.6)	37 (56.1)	
Acetylsalicilyc acid	44 (37.0)	12 (18.2)	
P2Y12 inhibitor	10 (8.4)	2 (3.0)	0.006
Dual antiplatelet	25 (21.0)	15 (22.7)	
NYHA Class			<0.001
1	7 (5.9)	31 (48.4)	
2	83 (69.7)	27 (42.2)	
3	21 (17.6)	6 (9.4)	
4	8 (6.7)	0 (0.0)	
Age (years)	70.48±12.09	68.38±13.02	0.273
BMI (kg/m2)	29.23±2.22	28.83±2.64	0.284
EF (%)	38.43±14.70	36.97±13.53	0.507
Left atrium (mm)	40.14±7.48	36.82±4.64	0.008
SBP (mm Hg)	128.85±18.97	131.53±21.58	0.385
DBP (mm Hg)	72.03±10.34	72.73±11.74	0.679

eGFR (mL/min/1.73 m2)	68.99±23.97	65.60±28.20	0.390
Hemoglobin (g/dL)	12.74±2.13	11.82±1.99	0.005
LDL (mg/dL)	89.73±34.30	89.36±36.94	0.950
Trigliserit	142.13±97.22	125.95±54.40	0.254
QRS (msn)	115.50±30.54	120.20±29.71	0.319
QTc (msn)	425.91±72.93	457.39±48.30	0.002
PR (msn)	185.30±52.29	178.88±43.16	0.525
Sodium (mmol/L)	138.14±13.04	136.14±3.23	0.221
Potassium (mmol/L)	4.43±0.54	4.50±0.50	0.387
Calcium (mg/dL)	1.06±0.13	1.01±0.11	0.056

Group 1: pre-earthquake group; Group 2: post-earthquake group
ACEI/ARB=angiotensin-converting enzyme inhibitor/angiotensin receptor blocker; BMI= body mass index; CABG=coronary artery bypass greft; CCB=calcium channel blockers; CIED= cardiac implantable electronic devices; CRT=cardiac resynchronization therapy; DBP=diastolic blood pressure; DM=diabetes mellitus; EF=ejection fraction; eGFR=estimated glomerular filtration rate; ICD=implantable cardioverter–defibrillator; HT=hypertension; LDL=low-density lipoprotein; MI=myocardial infarction; MRA=mineralocorticoid receptor antagonist; NOAC=new oral anticoagulants; NYHA=New York Heart Association; PCI=percutaneous coronary intervention; SBP=systolic blood pressure

Indications for hospitalization for device implantation are shown in Figure 1.

In terms of electrocardiographic parameters, corrected QT (QTc) level was found to be significantly higher in the post-earthquake group ($p<0.05$). In the study, it was seen echocardiographically that the left atrium was significantly larger and the number of patients with aortic and mitral insufficiency was higher in the pre-earthquake group ($p<0.05$).

Laboratory analyses showed that hemoglobin values were significantly lower ($p<0.05$) and calcium values were borderline significantly lower in the post-earthquake group ($p=0.056$).

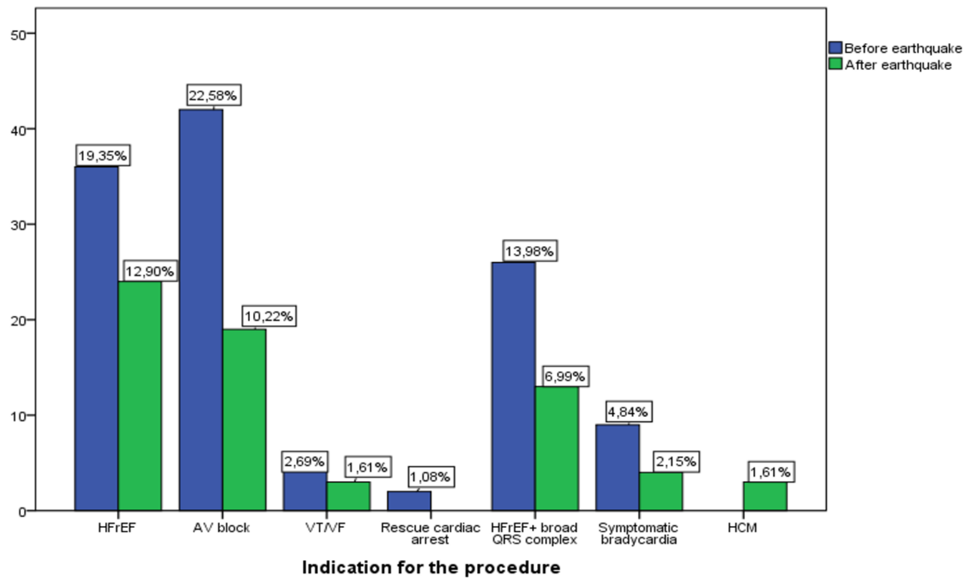

Figure 1. Indications for device implantation.

HFrEF : heart failure with preserved ejection fraction; VT/VF : ventricular tachycardia/ ventricular fibrillation; HCM : hypertrophic cardiomyopathy

Although the number was higher before the earthquake, no significant difference was found between the pre- and post-earthquake groups in terms of CIED rates (biventricular pacemakers, VVIR/DDDR and ICD). Figure 2 shows that no cardiac device implantation was performed in the 3-month period following the earthquake.

When we evaluated patients with CIED separately, unlike the overall group results, the rate of coronary stenosis increased significantly in the post-earthquake group of patients with ICD implantation ($p<0.05$). For bradycardia pacemakers (VVIR/ DDDR); low hemoglobin level, increased oral anti-diabetic drug use, low serum sodium and high potassium levels are significantly prominent in the post-earthquake group ($p<0.05$). In patients with biventricular pacemaker implantation; diabetes rate, oral antidiabetic use, percutaneous coronary intervention rates, ACEI/ARB use, and MRA use were found to be significantly higher in the pre-earthquake group ($p<0.05$).

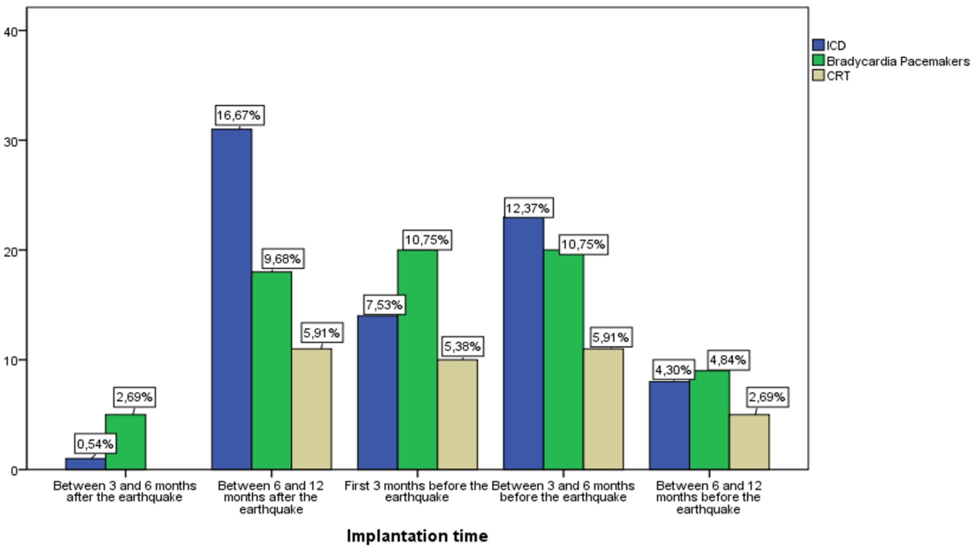

Figure 2. Time course of cardiac device implantation

CRT : cardiac resynchronization therapy; ICD : implantable cardioverter–defibrillator

New York Heart Association Classification (NYHA) class was significantly higher in the pre-earthquake group compared to the post-earthquake group ($p<0.05$). Before the earthquake, NYHA III-IV patient groups consisted of patients with lower ejection fraction, higher rates of moderate-severe mitral regurgitation, more dilated left atrium, longer QTc on ECG, more diabetes, more history of percutaneous coronary intervention, higher rates of atrial fibrillation, and more use of oral anti-diabetics, β-blockers, antiplatelet agents, and MRAs compared to the NYHA I-II patients ($p<0.05$). Before the earthquake, biventricular pacemaker and ICD were implanted more frequently in the NYHA III-IV patient group, and bradycardia pacemakers were implanted more frequently in the NYHA I-II patient group ($p<0.05$). During the follow-up, cardiac mortality was found to be higher in the pre-earthquake group in NYHA 3-4 patients compared to NYHA 1-2 ($p<0.05$).

After the earthquake, NYHA III-IV patient groups consisted of patients with lower ejection fraction compared to the NYHA I-II patients ($p<0.05$). After the earthquake, biventricular pacemakers were implanted more frequently in the NYHA III-IV patient group, and ICD and bradycardia pacemakers were implanted more frequently in the NYHA I-II patient group ($p<0.05$). No difference was found between the NYHA groups in terms of mortality and complication development ($p>0.05$).

Table 2 and Table 3 show the risk factors for ICD and bradycardia pacemaker implantation in the post-earthquake group, respectively. A model was not created for CRT because the number of patients was insufficient. 1 unit increase in age reduces the risk of ICD implantation after an earthquake by 1/0.926=1.080 times. 1 unit increase in QTc value increases the risk of ICD implantation after an earthquake by 1.010 times. The risk of ICD implantation after an earthquake is 3.587 times higher in those with a history of MI compared to those without. In the stenosis group, the risk of ICD implantation after an earthquake is 4.696 times higher in those with >50% coronary stenosis compared to those with <50% stenosis. The risk of ICD implantation after an earthquake is 1/0.081=12 times lower in those with NYHA III-IV compared to those with I-II.

1 unit increase in sodium reduces the risk of bradycardia pacemaker implantation after an earthquake by 1/0.713=1.403 times. 1 unit increase in Qtc increases the risk of bradycardia pacemaker implantation after an earthquake by 1.022 times. 1 unit increase in potassium increases the risk of bradycardia pacemaker implantation after an earthquake by 4.648 times. However, average calcium, sodium and potassium values are actually within the normal range.

Table 2. Univariate and Multivariate Analysis of the Potential Risk Factors for ICD Implantation in the Post-earthquake group.

	Univariate analysis		**Multivariate analysis**	
Variable	OR (95%CI)	p	OR (95%CI)	p
Age	0.922 (0.856-0.992)	0.030	0.926 (0.869-0.986)	0.016
Gender (Female)	2.042 (0.395-10.556)	0.394	-	-
DM (Absent)	0.964 (0.248-3.748)	0.958	-	-
MI history (Absent)	3.286 (0.622-17.368)	0.161	3.587 (0.928-13.793)	0.045
B-blocker (Absent)	0.729 (0.118-4.491)	0.733	-	-
ACEI/ARB (Absent)	0.565 (0.081-3.926)	0.564	-	-
MRA (Absent)	1.137 (0.230-5.607)	0.875	-	-
Coronary stenosis (<50%)	3.496 (0.769-15.894)	0.105	4.696 (1.168-15.886)	0.029
EF	0.974 (0.898-1.055)	0.516	-	-
QTc	1.009 (0.997-1.021)	0.143	1.010 (0.999-1.031)	0.050
Potassium	0.535 (0.130-2.195)	0.385	-	-
NYHA (I-II)	0.088 (0.009-0.838)	0.035	0.081 (0.009-0.721)	0.024

ACEI/ARB= angiotensin-converting enzyme inhibitor/angiotensin receptor blocker; DM= diabetes mellitus; EF= ejection fraction; ICD=implantable cardioverter–defibrillator; MI= myocardial infarction; MRA= mineralocorticoid receptor antagonist; NYHA=New York Heart Association

Table 3. Univariate and multivariate analysis of the potential risk factors for bradycardia pacemakers implantation in the post-earthquake group.

	Univariate analysis		**Multivariate analysis**	
Variable	OR (95%CI)	p	OR (95%CI)	p
Age	1.003 (0.919-1.094)	0.951	-	-
Gender (Female)	0.173 (0.020-1.504)	0.112	-	-
DM (Absent)	0.552 (0.101-3.013)	0.493	-	-
MI history (Absent)	1.041 (0.121-8.946)	0.970	-	-
Coronary stenosis (<50%)	0.312 (0.033-2.960)	0.310	-	-
EF	0.946 (0.857-1.044)	0.270	-	-
eGFR	1.008 (0.967-1.050)	0.712	-	-
QTc	1.026 (1.010-1.042)	0.001	1.022 (1.008-1.040)	0.001
Potassium	5.569 (0.917-30.815)	0.062	4.648 (1.076-20.072)	0.040
Sodium	0.602 (0.433-0.838)	0.003	0.713 (0.551-0.924)	0.010

DM= diabetes mellitus; EF= ejection fraction; eGFR= estimated glomerular filtration rate; MI= myocardial infarction

DISCUSSION

In this retrospective study, we designed to evaluate the device characteristics and clinical course characteristics of patients who underwent CIED implantation in the 12-month period before and after the devastating earthquake in Antakya, Turkey in 2023, to observe whether the earthquake had any effect on CIED and patient course (indications for hospitalization, patients clinics, CIED rates, complication rates, etc.) Although the number of CIEDs applied before the earthquake was approximately twice the number after the earthquake, no difference was found between the pre- and post-earthquake groups in terms of CIED rates (biventricular pacemakers, VVIR/ DDDR and ICD). The results showed that there was no significant difference in the type of complication rates for the implants before and after the earthquake. Patient symptoms (NYHA class) were found to be more severe in the pre-earthquake group.

It has been shown that acute cardiac events may increase after events that trigger mental stress (fear, work stress, traffic chaos, economic problems, traumas after natural disasters, etc.) depending on the factor causing the stress[8]. Among these stressful situations, earthquakes have devastating effects on the human body by creating both mental and mechanical trauma[9]. However, limited studies have investigated cardiac effects following earthquakes. Examining cardiac effects after an earthquake have often shown that patient clinical conditions worsen. It has been reported that cardiac deaths among hospitalized patients decreased during and after the earthquake. This may be due to the possible deterioration of hospital services during the earthquake period and the relocation of critically ill patients outside the city (in areas not affected by the earthquake). This has been discussed in previous post-earthquake studies[10].

Subsequently published studies evaluating the cardiac effects of earthquakes have frequently shown increased post-earthquake acute coronary syndrome, stroke and intracerebral hemorrhage, sustained VT, hospitalizations for heart failure, and mortality[11,12,13,14,15]. However, it has been shown that the mortality rate increases after an earthquake if the underlying cause is atherosclerotic heart disease[16].

In our study, atherosclerotic heart disease findings (CABG, PCI history and coronary stenosis rates) were similar between the groups (before and after the earthquake). Probably for this reason, mortality rates were similar between the groups during the follow-up period.

Apart from the cardiac symptoms and signs mentioned above, data on the relationship between earthquakes and CIED use are relatively scarce. In fact, Nakano et al.[2] published the clinical presentations and tachycardia frequencies of 189 CRT/ ICD patients who were implanted before the 2011 earthquake. They showed that patients had an increased frequency of ventricular arrhythmias and increased hospitalizations due to heart failure in the 6-month period following the earthquake. However, in our study, the patient groups before and after the earthquake were different. We compared the clinical characteristics of CIED and patients. In our study, no significant difference was found between the patients' application clinics and CIED indication rates were similar. In our study, it was observed that the electrocardiographic QTc levels of the patients after the earthquake were higher than the levels before the earthquake. When we examined the retrospective data, it was seen that serum calcium levels were lower after the earthquake compared to the levels before the earthquake and therefore the increase in QTc potentially increased the risk of both ICD and bradycardia pacemaker implantation. In fact, QTc and serum calcium levels were found to be within normal limits for both groups. This situation may be due to the deterioration of nutritional conditions after the earthquake.

One of the causes of QT prolongation after an earthquake may be the great stress experienced, and the effect of stress on QT prolongation has been shown in some studies. Stress-induced autonomic nervous system activation may have continued for a long time after the earthquake, as severe aftershocks continued for more than 1 year, which may induce mental stress[17,18]. Impaired sympathetic nervous system activation prolongs QT and increases the frequency of fatal arrhythmias (VF/VT) and sudden cardiac deaths due to the delay of the supranormal period of action potential phase 3. These patients usually cannot reach the hospital and sudden cardiac death occurs. The reason why fewer patients with advanced heart failure (NYHA III-IV) applied to our hospital after the earthquake may be due to the fact that these patients are more prone to arrhythmias and were not able to apply due to possible sudden cardiac death[19,20].

We observed that patients with advanced heart failure symptoms (NYHA III-IV) were more common before the earthquake than after the earthquake. In our study, the clinical picture of advanced NYHA patients before the earthquake can be explained by the fact that these patients had more advanced mitral insufficiency, increased left atrial levels, and lower EF compared to those with NYHA I-II. In our study, there may be some possible reasons why the NYHA classes of the patients who were applied CIED after the earthquake were lower than those before the earthquake. The devastating effects of the earthquake may have caused patient groups with worse clinical conditions (NYHA III-IV) to migrate to different cities that were not affected by the earthquake. Another possible reason why the NYHA class was lower after the earthquake than before the earthquake could be that the high NYHA (III-IV) groups were not able to survive the earthquake due to their low effort capacity.

However, studies showing changes in CIED characteristics before and after the earthquakes are unclear. In our study, although the rates of CIED types (biventricular pacemakers, VVIR/DDDR and ICD) are similar, the number of CIEDs applied after the earthquake decreased by half. Moreover, patient admission and device implantation indication rates (HFrEF, AV block, VT/VF, rescue cardiac arrest, HFrEF+ broad QRS complex, symptomatic bradycardia, hypertrophic cardiomyopathy) were similar between the pre- and post-earthquake groups, and some data (long QTc, increased coronary stenosis, increased age etc.) may have affected the post-earthquake device insertion rates.

Despite being the only hospital in the district that was actively working after the earthquake, other possible reasons in the decrease in the application rates of patients with poor clinical condition (NYHA III-IV) and the decreasing CIED rates may be due to the following reasons: inadequate functioning of public transportation vehicles in the city, damage to individual vehicles during the earthquake, insufficient financial means for patients for transportation, and insufficient bed capacity due to hospital congestion.

In our study, cardiac device implantation was not performed in the 3-month period following the earthquake. As a result, fewer CIEDs were probably deployed after the earthquake than before. The main reason for this was the risk of hospital-acquired infection after the chaos, the postponement of non-urgent operations, or in emergency cases, referral to out-of-town hospitals that were not affected by the earthquake after the necessary interventions (temporary pacemaker, etc.). A 3-month recovery period seems long, but this earthquake was the most devastating in the country's history.

In our study, implantable device application was frequently applied between 6 to 12 months after the earthquake, and CRT was not applied in the first 6 months. This may be due to postponement of cardiac device implantation, except in emergency situations (symptomatic bradycardia, VF/VT etc.). However, no significant difference was observed between the groups in terms of the rate of CIEDs before and after the earthquake. In addition, indications for cardiac device implantation before and after the earthquake were similar between the groups.

Our study has limitations. Many hospitals in the city were destroyed after the earthquake. Our clinic continued to operate as the only hospital where CIED could be applied after the earthquake. After the earthquake, many healthcare personnel died or migrated to different cities, and assignments were made from outside the city. This situation has led to a deterioration in the established functioning health system. The failure to apply a CIED device in the first 3 months after the earthquake and the disruptions in diagnosis and treatment during the chaos after the earthquake may have distorted the accuracy of the findings. Although the calcium level was within normal limits, the parameters that needed to be known to make the differential diagnosis of post-earthquake hypocalcemia (serum albumin, vitamin D, parathyroid hormone, phosphorus, etc.) were missing in the retrospective data. Due to the retrospective nature of our study and the possibility that inadequate post-earthquake patient records have been kept, deficiencies may have occurred in the retrospective review of data. For example, when patients were reviewed from the file and the database, all the medications they used (those that may cause QT prolongation, etc.) may not have been recorded.

However, such a study cannot be prospective. Although patient clinical assessment (NYHA etc.) is a scaled and standardized classification, it can be subjective.

As a result of assignments from external centers after the earthquake, patient assessment may have been kept at different thresholds by doctors.

In conclusion, the devastating effects of the earthquake in our hospital, unlike other studies, resulted in a decrease in patients with serious clinical conditions (NYHA III-IV) in the post-earthquake period. Cardiac devices were not implanted in our clinic during the first 3 months due to the post-earthquake recovery period, risk of infection, priority of more urgent operations, and bed needs (acute coronary syndromes, surgery for earthquake-related traumas, etc.). Complication and mortality rates after CIED implantation before and after the earthquake were similar.

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REFERENCES

1. Keven K, Ates K, Sever MS, Yenicesu M, Canbakan B, Arinsoy T et al. Infectious complications after mass disasters: the Marmara earthquake experience. Scand J Infect Dis. 2003;35:110-3.
2. 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;76:1283-5.
3. Akkuş O, Yasdıbaş R, Demirkıran RF, Elitaş V, Bekler Ö, Şen F et al. Changes in acute coronary syndrome clinic after the devastating earthquake in Türkiye. Anatol J Cardiol. 2024;28 446-53.
4. Glikson M, Nielsen JC, Kronborg MB, Michowitz Y, Auricchio A, Barbash IM et al. ESC Scientific Document Group. 2021 ESC Guidelines on cardiac pacing and cardiac resynchronization therapy. Eur Heart J. 2021;42:3427-520.
5. White PD, Myers MM. The classification of cardiac diagnosis. JAMA. 1921;77:1414-5.
6. Nielsen JC, Thomsen PE, Højberg S, Møller M, Vesterlund T, Dalsgaard D et al. A comparison of single-lead atrial pacing with dual-chamber pacing in sick sinus syndrome. Eur Heart J. 2011;32:686-96.
7. Al-Khatib SM, Stevenson WG, Ackerman MJ, Bryant WJ, Callans DJ, Curtis AB et al. 2017 AHA/ACC/HRS guideline for management of patients with ventricular arrhythmias and the prevention of sudden cardiac death: a report of the American College of Cardiology/American Heart Association Task Force on Clinical Practice Guidelines and the Heart Rhythm Society. Circulation. 2018;138:272-391.
8. Vancheri F, Longo G, Vancheri E, Henein MY. Mental stress and cardiovascular health-Part I. J Clin Med. 2022;11:3353.
9. Bartels SA, VanRooyen MJ. Medical complications associated with earthquakes. Lancet. 2012;379:748-57.
10. Katsouyanni K, Kogevinas M, Trichopoulos D. Earthquake-related stress and cardiac mortality. Int J Epidemiol. 1986;15:326-30.
11. Tsuchida M, Kawashiri MA, Termite 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. Circ J. 2009;73:1243-7.
12. Zhang XQ, Chen M, Yang Q, Yan SD, Huang de J. Effect of the Wenchuan earthquake in China on hemodynamically unstable ventricular tachyarrhythmia in hospitalized patients. Am J Cardiol. 2009;103:994-7.
13. 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;95:2009-13.
14. Nakamura A, Nozaki E, Fukui S, Endo H, Takahashi T, Tamaki K. Increased risk of acute myocardial infarction after the Great East Japan Earthquake. Heart Vessels. 2014;29:206–12
15. Kitamura T, Kiyohara K, Iwami T. The Great East Japan Earthquake and out-of-hospital cardiac arrest. N Engl J Med. 2013;369:2165–67.
16. Trichopoulos D, Katsouyanni K, Zavitsanos X, Tzonou A, Dalla-Vorgia P. Psychological stress and fatal heart attack: the Athens (1981) earthquake natural experiment. Lancet. 1983;8322:441-4.
17. Lecca LI, Portoghese I, Mucci N, Galletta M, Meloni F, Pilia I et al. Association between work-related stress and QT prolongation in male workers. Int J Environ Res Public Health. 2019;16:4781.
18. Andrássy G, Szabo A, Ferencz G, Trummer Z, Simon E, Tahy A. Mental stress may induce QT-interval prolongation and T-wave notching. Ann Noninvasive Electrocardiol. 2007;12:251-9.

19. Klabunde RE. Cardiovascular Physiology Concepts. Philadelphia, Williams &Wilkins, 2012.
20. Devkota A, Bakhit A, Dufresne A, Oo AN, Parajuli P, Manhas S. Arrhythmias and electrocardiographic changes in systolic heart failure. N Am J Med Sci. 2016;8:171-4.