The Impacts of The Earthquake on The Cardiovascular System

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Abstract

Aim: Various physiological and psychological effects of earthquakes can be seen on the human body, even without a direct physical impact from the earthquake. Both the experience of the earthquake process and the earthquake-related subsequent life changes cause stress through the activation of the sympathetic and parasympathetic systems in the body. This stress can affect various physiological processes, including the cardiovascular system. In this review, the effect of earthquakes on the cardiovascular system was aimed to be discussed in line with the available evidence.

Discussion: There are studies showing that natural events such as earthquakes increase the incidence of adverse cardiac events, such as myocardial infarction, heart failure, hypertension, and sudden cardiac death, or cause existing cardiac diseases to worsen during these periods. However, there are also some evidences with conflicting results. Therefore, the effect of earthquakes on cardiovascular diseases has not been clearly demonstrated yet.

Conclusions: Even survivors of earthquakes without physical injury are exposed to stress secondary to both internal and external factors. Studies indicate that individuals who are involved in the earthquake process may have adverse effects on cardiovascular health in the short and long term. Therefore, it is important to take necessary precautions and create appropriate conditions, especially in people with cardiovascular disease..

Keywords: *Earthquake, myocardial infarction, hypertension, sudden cardiac death.*

1. Introduction

The phenomenon of shaking the surface of the Earth through which the vibrations that occur suddenly due to fractures in the earth's crust spread as seismic waves is called an earthquake. Earthquake is an unavoidable natural event.[1] Since the formation of the world, earthquakes have occurred consecutively in seismically active regions, resulting in the destruction of millions of people and their shelters. Even if individuals who have experienced the earthquake process survive the process without physical injury, it is inevitable that there will be psychological effects. These individuals have to cope with the injuries and deaths of not only their families but also their friends and relatives, and they have to stay in emergency shelters and small-scale temporary housing or their relatives' homes for days or months.[2] For these reasons, individuals experiencing the earthquake process are exposed to acute and subacute psychological stress.[3]

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Stress affects the autonomic nervous system, hypothalamus-pituitary-adrenal axis by causing an allostatic load in the body in the long term and this causes effects on the cardiovascular, metabolic and immune systems. Being exposed to constant stress also causes less or more activation in the allostatic system, leading to disruptions in body regulation.[4] In other words, stress can harm the body by affecting the body physiology.[5] The magnitude of the threat, or the severity perceived by the individual, determines the magnitude of the individual's stress response to internal or external challenges.[4] Emotional or physical stress can affect acute and chronic diseases.[6-10] Unexpected natural events such as earthquakes can cause cardiovascular events by causing acute, subacute and chronic stress.[3] In this review, we aimed to compile the effects of the earthquake on the cardiovascular system.

1.1. Effect of earthquakes on acute coronary syndrome

Myocardial infarction is one of the most important causes of mortality and morbidity. In addition to well-known risk factors for myocardial infarction such as diabetes mellitus, hypertension, smoking, factors such as winter season, infections, physical exertion, insomnia and nervousness can also trigger myocardial infarction.[11-14] Studies draw attention to the fact that unexpected natural events can also trigger myocardial infarction.[15,16] There are conflicting

results in studies investigating the relationship between earthquakes and acute coronary syndrome.

The Great East Japan Earthquake with a magnitude of 9.0 and subsequent tsunami on March 11, 2011, severely damaged the region. During this period, the incidence of acute coronary syndrome in Fukushima Prefecture was studied. While no increase was observed in the incidence of acute coronary syndrome in all districts in this study, an increase was observed in the incidence only in Iwaki district in the subgroup analysis.[17] In a study conducted in patients with ST-elevation myocardial infarction in Iwate Prefecture, when the patients during the 2011 earthquake and the patients in the same time period in 2010 were examined, it was stated that there was no difference in the number of patients presenting with myocardial infarction, but the rate of percutaneous coronary intervention decreased and in-hospital mortality increased.[16] Another study conducted in Miyagi Prefecture showed that acute coronary syndromes increased in the early period but tended to decrease after 2-3 weeks.[18] Tanaka et al.[19] reported that the incidence of acute coronary syndrome increased in the first 4 weeks after the earthquake and then returned to its normal course. This study also examined the aftershocks of the main earthquake and the incidence of acute coronary syndrome during this period. As a result, it was seen that there is a positive correlation between seismic scale and admissions due to acute coronary syndrome.[19] In a single-center study by Nozaki et al.[20], it was stated that there was a significant increase in patients with acute coronary syndrome who applied to the emergency department when compared to previous years. Again, another study conducted in Iwate Prefecture compared the years 2009-2010 before the earthquake with the earthquake period and afterwards until 2014, and in this study, the areas affected by the earthquake and tsunami were divided into high impact zone and low impact zone. In this study, the number of non-fatal myocardial infarctions did not change according to years in both the high impact zone and the low-impact zone. The number of fatal myocardial infarctions did not change over the years in the low-impact zone. However, while fatal myocardial infarction increased significantly in the high impact zone compared to the predisaster period, this significant difference continued in the following 2012-2014 years.[21] In some studies conducted during the Hanshin-Awaji (1994), Athens (1981), The Noto Peninsula (2007) earthquakes, it was found that hospital admissions secondary to acute coronary syndrome increased after the earthquake.[22-24] When the relationship between the Newcastle earthquake (1989) and the incidence of myocardial infarction was examined, a statistically significant increase was not found in terms of fatal and non-fatal myocardial infarction, although there was a numerical increase.[25]

Brown et al.[26], in their study published with the hypothesis that the earthquake time and being awake or asleep may be important in acute coronary syndrome, compared the 1989 Loma Prieta and 1994 Northridge earthquakes; they suggested that the incidence of acute myocardial infarction when people were awake in the Loma Prieta earthquake at 05.04 pm was lower than the Northridge earthquake which occured at 04.31 am. A similar result was found in the Christchurch earthquakes. In the Christchurch earthquake, which happened at 4.36 am in 2010, the number of applications due to ST elevation myocardial infarction increased in the first two weeks, but a similar pattern was not found after the earthquake at 12.51 pm in 2011.[27]

The intense stress caused by earthquakes can activate the sympathetic system and the renin-angiotensin aldosterone axis, leading to myocardial damage and cardiac adverse outcomes. Sympathetic activity triggered by mental stress may trigger myocardial ischemia, especially in individuals with basal coronary artery disease.[13,28] In addition, interrupting antiischemic or antiaggregant treatment may lead to an increase in the incidence of acute coronary syndrome in the early post-earthquake period, as patients using drugs for coronary artery disease may have problems in accessing the drug after the earthquake. In the long term, it can be expected that there will be a chronic stress environment in earthquake survivors as they lose their relatives and accommodation opportunities. Studies have shown that there is an increase in waist circumference, body-mass index, weight, Hemoglobin A1c levels, decrease in HDL levels, deterioration in physical activity, mental health and socioeconomic status, especially in those who had to relocate after the earthquake.[2,29] Worsening of cardiovascular risk factors may also lead to increases in cardiovascular diseases in the long term.

1.2. Effect of earthquakes on congestive heart failure

When Nozaki et al.[20] compared the congestive heart failure patients admitted to the emergency department in the 3-week period following the 2011 Great East Japan Earthquake with the number of patients admitted in the same weeks in 2009 and 2010, they found a significant increase in the number of patients presenting with this diagnosis after the earthquake. In their study, Aoki et al.[18] showed that admissions to hospital with heart failure increased after the earthquake and that the applications entered a decreasing trend only in the 6th week of the event. Major events such as earthquakes can activate the sympathetic system and cause high blood pressure and heart rate.[30,31] In addition, during this period, the habits of patients such as eating and salt intake change due to unsuitable conditions.[18] In addition, during this period, it becomes difficult for patients with heart failure to access the drugs they regularly use. Apart from these, infectious diseases may increase due to the deterioration of accommodation opportunities, and the possibility of decompensation of heart failure patients increases with increasing infections.[32] For these reasons, hospital admissions of heart failure patients can be expected to increase after major natural disasters. After natural disasters, if suitable accommodation environments, proper nutrition, access to medicines, and hygienic environment are provided, worsening due to heart failure will be prevented.[33]

1.3. Effect of earthquakes on hypertension

Disasters are a serious source of stress for the body. With stress, physiological mechanisms are activated in the body, the sympathetic system and hypothalamic-pituitary-adrenal axis are activated, and the release of catecholamines and cortisol in the blood increases.[34] With this mechanism, an increase in blood pressure and an increase in hypertension and related cardiovascular events are expected in individuals under stress.[35]

In a study conducted during the Hanshin-Awaji earthquake, it was observed that hypertension patients with normally controlled blood pressure had high blood pressure in the 7-14 days after the earthquake, but regressed to the normal limits in the following 4-6 months.[36] Nishizawa also stated that blood pressure increase is transient after earthquakes and it mostly return to normal levels after the fourth week.[37] The post-earthquake elevation in blood pressure may be permanent in the elderly, those with chronic renal failure and microalbuminuria, metabolic syndrome or obese patients.[37-39]

In addition to the acute, subacute and chronic stress caused by the earthquake, dietary and salt intake habits may change, alcohol intake may increase, and weight gain may occur, which may cause metabolic disorders in the long term. This may lead to an increase in chronic diseases.[2,29,40] A study examining the incidence of post-earthquake hypertension in the long term was conducted by Ohira et al.[41] after the Great East Japan earthquake. When the individuals who were evacuated after the earthquake in Fukushima were examined in the 2-year follow-up, it was observed that the development of hypertension increased especially in males. Also Kobari et al.[40], in their 7-year follow-up study after the Great East Japan earthquake, stated that the development of hypertension increased in

earthquake victims. It has been determined that the reasons for this increase are the development of obesity in the affected individuals, the increase in alcohol consumption and evacuation from their settlements.

1.4. Effect of earthquakes on sudden cardiac death

The increase in cardiovascular-related deaths after major earthquakes has been discussed in previous studies.[23,25,42] When the 1994 Northridge earthquake was examined, it was determined that the incidence of sudden cardiac death in earthquake patients increased by 5 times on the day of the earthquake compared to previous years.[42] In the 1981 Athens earthquake, it was determined that sudden cardiac deaths increased in the first days after the earthquake.[43] In a similar study by Klooner et al.[44], it was determined that cardiac deaths increased within 14 days after the earthquake, and then decreased. During the Hanshin-Awaji earthquake, the incidence of cardiac death remained high for 4 months and then returned to normal limits.[45] In a study conducted in a single center in Iwake Prefecture during the Great East Japan earthquake, although an increase was found in the number of out-of-hospital cardiac arrests in the 3-week period after the earthquake, the difference was not statistically significant.[20]

It has been suggested that the mechanism underlying the increase in cardiac deaths after physical or emotional stress is the increased release of catecholamine and hypercoagulability factors after stress, which in turn may lead to coronary artery thrombosis by causing plaque rupture.[42,46-48] Emotional stress-induced myocardial ischemia and triggering of severe arrhythmias are likely to be the underlying mechanisms.[42]

2. Conclusion

Major natural events such as earthquakes cause serious loss of life and property, especially if the construction is not suitable for earthquakes. The survivors are exposed to life-threatening health problems, both secondary to trauma and organ damage. Survivors of the earthquake without physical injury are exposed to acute and chronic stress due to the earthquake, loss of life of their relatives, and having to leave their settlements. Studies have shown that there is an increase in cardiovascular diseases in the short and long term in individuals who have experienced earthquakes. The reasons for this increase may be the activation of the autonomic nervous system due to physical and mental stress, increase in blood pressure, inability to reach the medications they take routinely due to chronic diseases, and increase in salt intake as a result eating preserved food. In the light of this information, minimizing the post-earthquake stress and taking the necessary precautions for the continuation of appropriate health services, especially in individuals with underlying cardiovascular disease, will minimize the damage due to cardiovascular diseases.

Conflict of interest statement

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