DERLEMELER

Disaster and Cardiac Disease

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Evidence obtained over the past decade has revealed that cardiac events and sudden cardiac deaths do not occur randomly but are caused by daily activities and emotional stress. Important triggers may be stress on autonomic nervous tone and sympathetic activities. Such sympathetic activities are changed in a circadian manner with fluctuations in blood rheology and catecholamine secretion. The threshold of electrical instability, left ventricular dysfunction and coronary stenosis may become reduced through the acceleration of sympathetic tone due to emotional stress, thus causing malignant arrhythmia and plaque rupture. Recognition of this multifactorial pathophysiology provides a basis for understanding preventive strategies. *(Ana Kar Der, 2001; 1: 101-106)*
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Rates of mortality due to cardiac diseases increase after disasters such as earthquake, extreme heat or cold and war (1- 4). During the Northridge earthquake in Los Angeles and the Hanshin-Awaji earthquake in Japan, rates of mortality due to cardiac events significantly increased (5-7). Both earthquakes occurred in the morning and the effects of natural disasters of brief duration such as those affecting large populations at that time might be superimposed on the stress of awakening. This could result in enhanced triggering of acute coronary syndrome. Although the mechanisms of sudden cardiac death remain unknown, some triggers of sudden death are understood, because the incidence of myocardial infarction and tachyarrhythmias in the morning is significantly higher than at any other times of the day (8,9). These conditions might be related to endogenous factors modulated by vascular tone and blood pressure, heart rate, blood viscosity, platelet aggregation, catecholamine and cortisone levels, which are exaggerated in the morning (10,11). In this article, we address the pathophysiology of the onset of cardiac disease following disasters.

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Multifactorial Causes in Onset of Sudden Cardiac Death Triggered by Disasters

Several hypotheses have been proposed to explain the onset of sudden cardiac death at times of disasters. Ambulatory ECG monitoring and other procedures have shown that, the onset of overt or silent myocardial ischemia occurs in a circadian fashion. Furthermore, a study of forearm blood flow and its relationship to heart rate and the onset of ST segment depression identified a circadian relationship between heart rate and time to onset of ST segment depression (12). Mulcahy et al. reported that total ischemic burden (painful and silent myocardial ischemia) is maximal in the morning, with a trough just after midday followed by a further peak that declines again at night (13). Muller et al. (8) analyzed the onset of dying in a Massachusetts hospital in 1983 and found that the frequency of sudden cardiac death is higher in the morning than at other times of the day. This reflected the profile of stroke and arrhythmia onset. Platelet aggregation and levels of serum catecholamine also move in circadian rhythms (10,11). In general, the sympathetic nervous system exerts profound effects on the coronary blood vessels mediated by neural and hormonal (norepinephrine, epinephrine) routes: coronary blood vessels respond to sympathetic alpha-receptor stimulation by vasoconstriction, whereas vagal stimulation produces coronary vasodilatation. An apparently constant,

low-grade coronary vasoconstriction under resting conditions is mediated by the sympathetic nervous system (14). These pathophysiological activities may appear in the beat-to-beat variability of the heart rate, which depends on instantaneous variations in the balance of the autonomic nervous system and exhibits fluctuations around the mean heart rate. Huang et al. reported that autonomic functions are significantly changed after earthquakes; they analyzed heart rate variability in individuals wearing ambulatory 24-hour Holter electrocardiographic monitors at the time of the earthquake in Nan-Tou area in the central part of Taiwan, September 21,1999 (15). Patients who were not taking beta-blockers during the earthquake developed increased sympathetic modulation and withdrawal of parasympathetic activity. This sympathovagal imbalance resulting from reactions to the earthquake was not prominent in patients who were taking beta-blockers. Therefore, sudden cardiac death following disasters might be mainly triggered by sympathetic nervous system that secretes catecholamines, secondarily to vasoconstriction, increases platelet aggregation and changes blood rheology. These triggers may affect the conduction system, myocardial tissue and the coronary arteries. Furthermore, these triggers might cause malignant arrhythmia in electrical instability, an effect on neurohormonal factors secondary to accelerated heart failure in LV dysfunction and plaque rupture in the coronary arteries secondary to coronary obstruction. Finally, these multifactorial elements might cause cardiac events and sudden cardiac death (Fig 1).

Vascular Endothelial Function and Disasters

Coronary heart disease and its consequences account for the most sudden cardiac deaths either due to plaque rupture and/or an electrophysiological mechanism related to autonomic nerve activities. The mechanism of plaque rupture might be focused in recent basic and clinical studies. Vascular endothelial injury is a critical initiating event in atherogenesis. Fuster et al. proposed that pathophysiological vascular injury is associated with acute coronary syndrome (16). When plaque rupture occurs, a significant quantity of thrombogenic substances are released and the coronary artery lumen may become obstructed by a combination of fibrin, platelet aggregates, and red blood cells (17). The rupture of plaque is considered the most common pathophysiological initiator of acute coronary syndrome. Atherosclerosis and its thrombotic complication are responsible for cardiac death among most Western populations (18). As atherosclerotic lesions grow, they may limit blood flow to the myocardium and if progression is rapid, such as during plaque rupture accompanied by luminal thrombosis, then acute ischemic syndromes such as unstable angina and myocardial infarction can develop. Atherosclerotic intima tends to develop in lesion-prone areas that are subject to repeated mechanical forces with an influx of low-density lipoproteins and other plasma proteins into the intima, which cause dysfunctional endothelium. Additionally, circulating monocytes adhere to activated endothelial cells, such as E-selectin, vascular cell adhesion molecule 1 (VCAM-1), or intracellu-

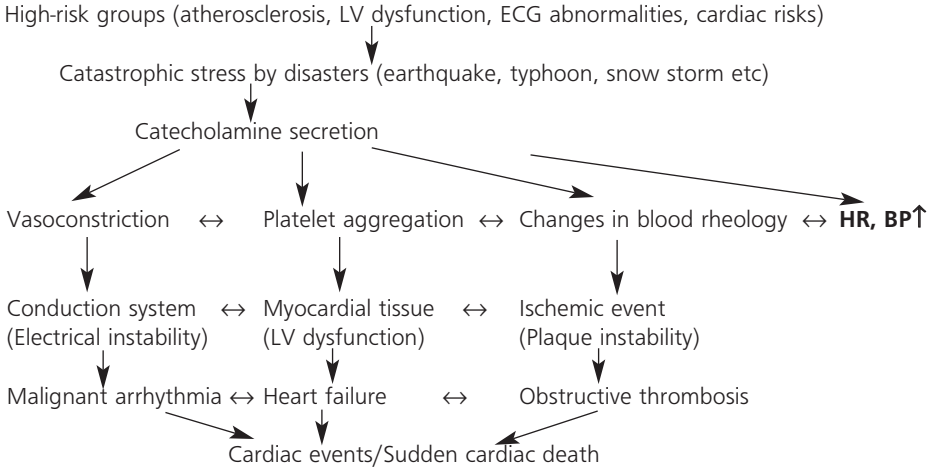

Figure-1: Multifactorial elements involved in onset of cardiac events and/or sudden cardiac death triggered by disasters.

lar adhesion molecule 1 (ICAM-1), pass between endothelial cells and enter the intima where they differentiate into macrophages and oxidized LDL (19-23; Fig. 2). Under these circumstances, mechanical stress may play an important role in plaque rupture. The sudden accentuation of wall stress may directly trigger plaque rupture as well as chronic stresses on the coronary arteries. Plaque rupture may be triggered by emotional stress secondary to disasters. As described above, a sudden surge in sympathetic activity with an increase in blood pressure, heart rate, force of cardiac contraction and coronary blood flow during emotional stress may lead to plaque disruption. Coronary vasospasm also triggers plaque rupture by compressing the atheromatous core and causing lipid release into the lumen. Therefore, the autonomic nerve control of the heart may play an important role in causing plaque stability and/or provide an important physiological link between physical and psychosocial factors in the generation of fatal arrhythmias.

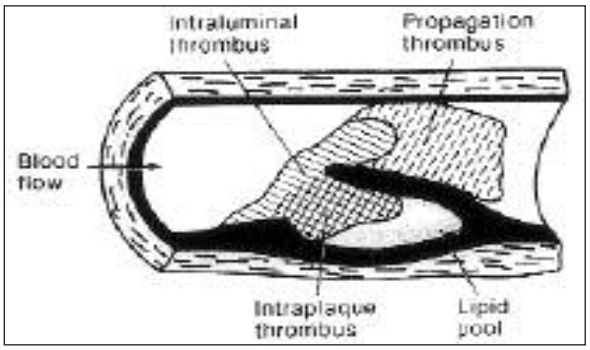

Figure-2: Histological components of an occluding thrombus. Large thrombus at the site of occlusion is seen within the plaque and compresses lumen from outside. Plaque-rich thrombi develop at surface of atherosclerotic lesions in which circulating monocytes adhere to activated endothelial cells mixed with E-selectin, vascular cell adhesion molecule 1 or intracellular adhesion molecule 1 (Davies MJ, Circulation 1990; 82: Supple II:38-45, 23).

Prevention of Cardiac Events and Sudden Cardiac Death Triggered by Disasters

Cardiac events and sudden cardiac death triggered by disasters are usually activated by the sympathetic nervous system secondary to the cardiovascular system. The protective cardiovascular functions of the elderly and of patients with coronary artery disease, arrhythmia or structural heart diseases against emotional stress induced by disasters might be weakened. Therefore, their autonomic nerve functions might be more susceptible than that of younger, healthy persons. Since the principles of preventing cardiac events and sudden cardiac death triggered by disasters do not differ from those due to other causes, we address general prevention methods and approaches. Since ischemic heart disease is the main cause of sudden cardiac death, any reduction of ischemic heart disease should have a favorable effect on sudden cardiac death. Therefore, minimizing coronary risk factors, such as hypertension, smoking, obesity, diabetes and imbalances of autonomic nerve tone are important issues involved in primary prevention. Except ischemic heart disease, sudden cardiac death is more frequently associated with structural heart diseases such as cardiomyopathies, valvular heart disease, long QT syndrome, congenital heart disease, and preexcitation syndrome (13). Such patients should undergo regular physical examinations at least twice per year and the findings should be collected into data files. Furthermore, in patients with electrolyte abnormalities, ventricular arrhythmia may be facilitated. According to the Cardiac Arrhythmia Suppression Trial (CAST), antiarrhythmic agents, especially those of class IC applied after myocardial infarction rather increase the incidence of sudden cardiac death (24,25). In addition, short acting calcium antagonists (26-28) and nitrates increase the rate of sudden cardiac in patients with old myocardial infarction (29,30). Hence, medications prescribed for such patients should be carefully monitored, as well as serum electrolyte data, 12 lead ECG to check QT intervals, ST segment changes and ventricular arrhythmia. Table 1 shows three major approaches to prevent cardiac events and sudden cardiac death. In patients with ventricular malignant arrhythmia, the occurrence of arrhythmia and heart rate variability should be monitored using an ambulatory Holter ECG. Heart rate variability gives

Tablo-1: Physical conditions and methods of detection applied at our outpatient clinic.

Physical conditions	Detection techniques
Electrical instability:	Holter ECG (arrhythmia, ischemia, heart rate variability)
	Late potentials (microvoltage
	T wave alternans (LV microwave)
	QT intervals (QT dispersion
Myocardial ischemia:	EX testing, Holter ECG, coronary angiography
	Blood samples (troponin T, I, CK-MB
LV dysfunction:	ECHO, isotope technique (scintigram)

important information about the sympathetic-parasympathetic autonomic balance, which is especially useful in epidemiological studies to predict arrhythmic events or sudden cardiac death after myocardial infarction and/or congestive heart failure (31-33). The Task Force of the European Society of Cardiology and the North American Society of Pacing and Electrophysiology (34) has confirmed that a reduction in standard deviation of RR intervals is a sign of increased sympathetic activity and the expression of reduced parasympathetic activities. Three major components of the heart rate variability spectrum have been reported with frequencies around 0.0 Hz (VLF; very low frequency), a band between 0.01 to 1.0 Hz (LF; low frequency) and a band between 0.10 to 0.40 Hz (Hz; high frequency). Our studies as well as the findings of the Task Force have confirmed that HF is due to parasympathetic activity, while the LF/HF ratio mainly reflects sympathetic activity and the sympatho-vagal balance (35). Late potentials and T wave alternans are also useful methods of detecting electrical instability, especially in patients after myocardial infarction and left ventricular dysfunction (36,37). Furthermore, late potentials and QT dispersion should be considered applicable in this situation, since these techniques are useful means of predicting cardiac events and sudden cardiac death (38-40). Exercise stress testing as well as thallium scintigraphy should be applied to patients with myocardial ischemia. When patients present with chest pain accompanied by ST segment changes, coronary angiography should be performed. When left ventricular dysfunction would be suggested, echocardiography as well as isotopic techniques to measure ventricular function should be performed. These procedures can be applied on an outpatient basis and may help to prevent sudden cardiac events and cardiac death. Since apparently normal individuals can die of a sudden cardiac event, physical examinations should be undergone at least twice per year and biochemical data including blood samples should be checked annually (41). At the National Defense Force in Japan, we identified an incidence of at least 6 to 7 sudden cardiac deaths per 130, 000 deaths per annum (42). We found that the weight of the heart estimated by 12 scalar ECG was heavier (>350 g) in those six of 7 individuals, and the incidence of abnormal ECG and lipidemia was higher. We found that approximately 80% of sudden cardiac deaths were associated with ventricular hypertrophy. Therefore, the detailed health examinations in those subjects who have heart weight over 350 g, should include ECHO, Holter ECG and stress ECG studies.

Conclusion

Circadian variation in sympathetic activity, vascular reactivity and platelet aggregation might be factors involved in the development of sudden cardiac events and sudden cardiac death in the morning. Such events also found during disasters. The main triggers due to disasters affect the stimulation of autonomic nerve tone secondary to lowering the threshold of coronary artery plaque rupture and malignant arrhythmia. The current study demonstrated that the mechanism of cardiac events and sudden cardiac death is associated with the mechanism of plaque rupture and malignant arrhythmia. These aspects should be studied in detail and recent advanced techniques should be applied to prevent cardiac events and sudden cardiac deaths not only after disasters but also in outpatient clinics. This will be important especially for the elderly and those individuals who have coronary risks factors.

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