

Effect of the Kobe Earthquake on Stress and Glycemic Control in Patients With Diabetes Mellitus

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Objective: To examine the effects of the Kobe, Japan, earthquake, a life-threatening event, on stress and glycemic control in diabetic patients.

Patients and Methods: Hemoglobin A_{1c} levels before and after the earthquake were evaluated in diabetic patients in Kobe (N=157; magnitude, 7.2) and in Osaka, Japan, as a control (N=277; magnitude, 4.2), where little damage to houses and traffic facilities occurred. Glycosylated hemoglobin levels were also compared with those of 2 years before and 1 year after the earthquake. The General Health Questionnaire (GHQ) and a self-administered questionnaire regarding damage to houses and relatives killed or injured were used to assess psychological and mental stresses on earthquake survivors.

Results: Glycemic control was aggravated in diabetic patients after the earthquake in Kobe but not in Osaka. The GHQ scores were significantly higher in the patients in Kobe than those in Osaka. Increased hemoglobin A_{1c} concentrations and high scores on the GHQ were especially evident in diabetic patients with severe damage to houses and/or with relatives killed or injured.

Conclusion: These results suggest an association between chronic, life-threatening stress and the worsening of metabolic control in patients with diabetes mellitus.

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IN VARIOUS countries, including Japan, the threat of severe earthquakes has led to the development of antidisaster plans to prepare for catastrophic medical events and to prevent health crises. Nevertheless, when the Kobe earthquake occurred on January 17, 1995, with a magnitude of 7.2 on the Richter scale, hospitals in the Kobe area equipped with modern medical facilities and technologies suffered severe structural and nonstructural damage.¹ The earthquake greatly affected not only patients with chronic conditions like anorexia nervosa² and kidney failure requiring hemodialysis³ but also the medical staff.⁴

The results of studies of animal models of diabetes suggest that psychosocial stress may play a role in either or both the onset and the metabolic control of diabetes mellitus. Studies of the influence of stress, however, have yielded mixed results on metabolic control—ie, an increase, no change, or a decrease in blood glucose levels—when random samples of patients with type 1 diabetes are examined.⁵ An early study suggests that feelings of anxiety and tension might be associated with decreases in glucose levels,

whereas those of anger and resentment might be associated with increases in glucose levels.⁶ Almost all studies, however, were of short-term psychological stress.

The aim of this study, therefore, was to examine the effects of the Kobe earthquake on patients with diabetes mellitus, with special emphasis on life-threatening stress and glycemic control after this traumatic event. Because this is not a prospective study, we first examined the glycemic control and psychological effects of the earthquake by comparing the hemoglobin (Hb) A_{1c} levels and the General Health Questionnaire (GHQ)^{7,8} scores of diabetic patients in Kobe with those of patients in Osaka where a magnitude 4.2 earthquake hit but produced little damage to houses and traffic facilities. We then examined the long-term effects of the Kobe earthquake on glycemic control in diabetic patients in Kobe.

RESULTS

There were no differences between the patients from Kobe and those from Osaka with regard to age (59.3±1.2 vs 58.8±0.7 years), sex (female:male, 80:77 vs 105:112), insulin treatment (51 of 157 pa-

PATIENTS AND METHODS

PATIENTS

We studied 434 diabetic outpatients, 157 of whom lived in Kobe and the other 277 in Osaka. The patients recruited into the study received routine care in the diabetic clinics of Kobe University Hospital and Osaka Medical College Hospital and had responded to the questionnaires. The patients who did not complete or declined to fill out the questionnaires were not included in the study; they made up less than 20% and 10% of the total number of diabetic patients in Kobe and Osaka, respectively. Informed consent for participation in the study was obtained from all these patients. Glycemic control was evaluated in terms of HbA_{1c} levels (normal, 0.043-0.055 [4.3%-5.5%]), which were determined by high-performance liquid chromatography. The HbA_{1c} levels were measured and the questionnaires administered about 2 months after the earthquake. The HbA_{1c} levels that were measured 1 to 2 months before the earthquake were also collected from the medical records of patients. The amount of time that elapsed between the disaster and the outcome measurements was the same for the patients of both Kobe and Osaka.

QUESTIONNAIRES

The GHQ^{7,8} is a self-administered questionnaire containing 60 questions concerned with psychological distress or altered behavior. It starts with questions that have a somatic bias and gradually progresses to questions eliciting more overtly psychiatric content, with the questions that were considered to be potentially most disturbing occurring at the end. All 60 questions were scored according to the simple GHQ scoring method: absent, 0; present, 1. For example, answers were categorized as follows: "Not at all" and "No more than usual" were scored as 0; "Rather more than usual" and "Much more than usual" were scored as 1.

A patient's total score is the sum of measures for every question, as indicated in the above example, this total score being taken to represent a person's psychiatric state. The GHQ data were further analyzed according to 4 factors,⁶ which were stress-related somatic symptoms, sleep disturbances or anxiety, social dysfunction, and severe depression. With this analysis of the GHQ, we have recently demonstrated that the Kobe earthquake had a great effect on the mental health of our medical staff⁴ and on the feeding behavior of some patients with anorexia nervosa.²

Self-administered questionnaires were also used to collect data about the severity of damage to houses or the presence of fatalities or injuries within patients' families or among relatives. The questions are as follows:

1. How much damage did you have to your residence?
 - a. No damage.
 - b. Able to be inhabited with some repairs.
 - c. Damaged or burned (hardly possible to inhabit).
 - d. Completely damaged or burned.
2. How were you rescued?
 - a. I was able to rescue myself and my belongings.
 - b. I was able to rescue myself but unable to save my belongings.
 - c. I was confined in the rubble but eventually freed myself.
 - d. I was confined in the rubble but eventually was saved by neighbors and/or rescue workers.
3. What was the condition of your family members after the earthquake?
 - a. All members were fine.
 - b. (An) acquaintance(s) was (were) killed.
 - c. (A) relative(s) and/or close friend(s) was (were) killed.
 - d. (A) family member(s) (parents, children, or partner) was (were) killed.
4. As of now, do you have adequate water supply, electricity, and gas services?
 - a. No problems.
 - b. Minimal problems with little inconvenience.
 - c. Living conditions are quite inconvenient.
 - d. Everyday life is extremely difficult because of living conditions.

FOLLOW-UP STUDY

To examine the long-term effects of the Kobe earthquake on glycemic control, 70 patients of 62.3±1.6 (mean±SE) years of age with diabetes mellitus were studied, all of whom were available for monthly measurements of plasma HbA_{1c} levels from at least 1993 and who lived in the city areas most destroyed after the earthquake.

STATISTICS

Statistical analysis was performed by analysis of variance, Student *t* test, and χ^2 test where appropriate (StatView, Abacus Concepts Inc, Berkeley, Calif).

tients from Kobe were taking insulin vs 69 of 277 patients from Osaka), and socioeconomic status except for the ratio of non-insulin-dependent diabetes mellitus to insulin-dependent diabetes mellitus among the patients (147:10 vs 271:6, $\chi^2=50.56$, $P<.01$). The relatively small number of patients in the group from Kobe was partly due to patients' deaths or transfers to other hospitals during and after the Kobe earthquake. The number of such patients, however, was less than 10% of the total number of diabetic patients in Kobe 1 to 2 months after the earthquake, suggesting that our patients were representative of diabetic patients in Kobe and that selection biases were kept to a minimum. Because the GHQ scores

were not available before the earthquake for patients in Kobe, we included diabetic patients in Osaka as a comparison, who experienced less effects of the earthquake with minimum damage to households and no injury to family members.

As shown in **Table 1**, the GHQ scores of the diabetic patients in Kobe were significantly higher than those in Osaka. These higher scores were observed in essentially all age groups of the patients, from the 20s through the 70s. When the GHQ was analyzed according to the 4 factors listed earlier,⁸ there was a significant difference in stress-related somatic symptoms, sleep disturbances and anxiety, and social dysfunction between the

Table 1. Total Scores of 60-Item General Health Questionnaire (GHQ) Given to Diabetic Patients in Kobe and Osaka, Japan, 2 Months After the January 17, 1995, Earthquake*

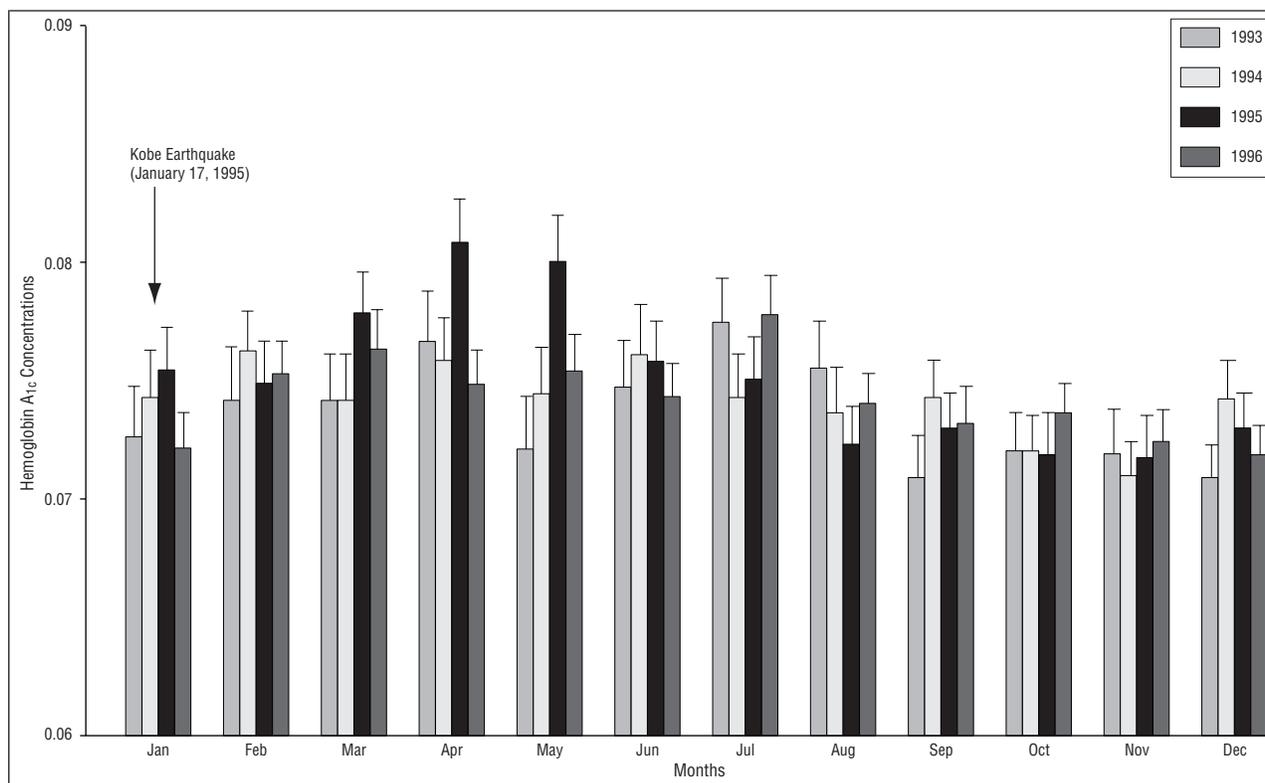
Patients	Age Group, y							
	20-39	40-49	50-59	60-69				
Kobe	16.63±3.91 (16)	19.24±3.38 (17)	19.97±2.67 (32)	13.65±1.71 (49)				
Osaka	9.36±2.83 (11)	13.62±1.86 (37)	9.35±1.06 (84)	9.19±0.89 (107)				
	<i>P</i> =.18		<i>P</i> =.12		<i>P</i> <.001		<i>P</i> <.05	

*The results are expressed as mean±SE (number of patients). The cutoff value of the GHQ in the general population of Japan is 12/13.

Table 2. Scores of 4 Factors on the 60-Item General Health Questionnaire Given to Diabetic Patients in Kobe (N=157) and Osaka (N=277), Japan, 2 Months After the Earthquake*

Patients	Somatic Symptoms	Sleep Disturbance or Anxiety	Social Dysfunction	Severe Depression		
Kobe	2.25±0.18	2.77±0.17	1.90±0.18	0.82±0.14		
Osaka	1.74±0.12	1.76±0.11	0.79±0.08	0.57±0.08		
	<i>P</i> <.001		<i>P</i> <.001		<i>P</i> =.19	

*The results are expressed as mean±SE.



Glycosylated hemoglobin concentrations (expressed as a fraction of 1) in diabetic patients before and after the January 17, 1995, Kobe earthquake. The number of patients per month was 60 to 70.

patients of the 2 districts (**Table 2**). Stress-related somatic symptoms include “feel tightness or pressure in the head,” “feel run down and out of sorts,” “feel ill,” “getting pains in the head,” “not feeling well or in good health,” “have no energy,” and “feel too tired even to eat.” Social dysfunction is expressed in the items such as “not capable of making decisions,” “not doing things well,” “not able to face problems,” “not able to enjoy day-to-day activities,” “not satisfied with carried-out tasks,” “feel useless,” and “taking longer to do things.” There was no

difference in the subscale of the GHQ, severe depression. Hemoglobin A_{1c} levels were significantly increased after the earthquake in the patients of Kobe (0.0744±0.0015 vs 0.0764±0.0011 [7.44%±0.15% vs 7.64%±0.11%]; n=110; *P*<.01), whereas they were not in the patients of Osaka (0.0776±0.0044 vs 0.0774±0.0018 [7.76%±0.44% vs 7.74%±0.18%]; n=270).

Follow-up studies showed that the HbA_{1c} levels peaked 3 to 4 months after the earthquake. As shown in the **Figure**, HbA_{1c} levels of the prequake years 1993-

70-89	Total
17.72±2.36 (43)	17.36±1.15 (157)
12.26±1.83 (38)	10.23±0.60 (277)

P=.08 P<.001

Table 3. Psychological Distress as Expressed in Total General Health Questionnaire (GHQ) Scores and Worsening Glycemic Control in Diabetic Patients in Kobe, Japan

Indicator of Distress	Severe Damage to Houses*	Relatives Killed or Injured†
Hemoglobin A _{1c} level, % increase±SE	2.6±3.6 2.7±2.1	11.1±3.3 6.7±1.4
Total GHQ score±SE	26.4±4.9 17.3±2.3	33.8±8.6 18.5±1.8

P<.05 P=.44
P=.26 P<.05

*The number of patients who gave positive responses=21; negative responses=103.

†The number of patients who gave positive responses=7; negative responses=116.

1994 and postquake year 1995 generally were lower in September through December and higher during the rest of the year. The levels in 1995 were raised and peaked in April and May (the absolute increase, 0.0075 [0.75%]) compared with those of the other years. These levels returned to the prequake levels in June. The pattern of the annual change of HbA_{1c} levels was different from that observed before the earthquake and a year after it.

Table 3 shows the worsening of glycemic control and the psychological distress as observed in high scores on the GHQ for diabetic patients with severe damage to houses (n=21) and/or fatalities or injuries within their families or among relatives (n=7). The magnitude of the increases of HbA_{1c} levels, as expressed in percent changes because of the small number of patients, coincided with the high scores on the GHQ.

COMMENT

Stress causes various behavioral, endocrine, and autonomic changes in humans. Thus, emotional stress is thought to have considerable effects on metabolic control in patients with diabetes mellitus. On January 17, 1995, Japan experienced a disastrous earthquake¹ that killed more than 6000 people and left homeless more than 250 000 citizens in Kobe. With this unique life-threatening event occurring in the lives of these people, we decided to study the metabolic control of diabetes mellitus in patients after the earthquake.

Although the immediate psychological aftermath of the disaster could not be examined because of the confusion in our university hospital, we were able to study the long-term effects of the earthquake on glycemic control and psychological stress. The GHQ was

used as a screening instrument to detect possible psychiatric problems or disorders. This questionnaire has been widely used in various countries and different settings, including general practice and the community.^{7,8} Higher GHQ scores in patients with insulin-dependent diabetes than in control subjects were described previously,^{9,10} but, to our knowledge, the effects of life-threatening disasters such as earthquakes on diabetes mellitus have not been reported. The diabetic patients in Kobe were found to have significantly higher GHQ scores than those in Osaka, who had scores near the cutoff values for the general population in Japan. Significant differences were observed in somatic symptoms, sleep disturbances and anxiety, and social dysfunction, which could affect patients' compliance behaviors in ways that lead to difficulties in metabolic control. Although the earthquake did not substantially increase the occurrence of severe depression, this might be due to patients being in the heroic stage,¹¹ as noted in other Kobe citizens when the GHQ was administered (M.U., unpublished data, 1997). These results suggest a serious psychological effect on diabetic patients. A significant, albeit small, elevation of HbA_{1c} levels after the earthquake might be the sum of the mixed results as observed in short-term psychosocial stress. There is no essential difference in the results between patients with non-insulin-dependent diabetes and those with insulin-dependent diabetes (A.I., unpublished data, 1997). It has yet to be determined whether persons such as those with type A behavioral patterns⁵ may be at risk for having greater metabolic responses to psychosocial stress. Although the increase of HbA_{1c} levels is likely related to other factors such as the inevitable disruption of lifestyle, diet, and access to medication, a high GHQ score, suggesting psychosocial stress, indicates an association between chronic stress and glycemic control. Follow-up studies demonstrate that this is especially the case for the patients who suffered severe damage to their houses and/or who had relatives killed or injured. The number of cases of acute myocardial infarction increased within the first 3 weeks after the earthquake.¹² Therefore, the Kobe earthquake appears to have induced emotional stress of both acute and chronic natures, and the chronic stress might be of more importance for glycemic control in diabetic patients.

Our study demonstrated that psychological problems after the devastating Kobe earthquake may be responsible for the aggravation of glycemic control in diabetic patients, possibly through changes in neuroendocrine regulatory mechanisms and patients' compliance behaviors. The scale of the earthquake was beyond all expectations, and the contingency plans for a large disaster proved to be totally inadequate.^{1,13} Even a highly organized and affluent society may be brought to a standstill when it is hit by a disaster of this magnitude. Our studies suggest that antidisaster programs should include psychosocial interventions for patients with chronic diseases like diabetes mellitus, anorexia nervosa,² or kidney failure requiring hemodialysis³ and for elderly people¹³ and medical staff.⁴

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