

Hypertension

Blood Pressure Reactivity and Recovery to Anger Recall in Hypertensive Patients with Type D Personality

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Background: Type D, otherwise known as distressed personality type, has been associated with an increased risk of cardiovascular morbidity and mortality. Blood pressure reactivity and recovery to stress could be a possible underlying pathway linking type D personality and cardiovascular events.

Methods: A total of 41 patients with hypertension were recruited from a regional hospital in southern Taiwan. Demographic and clinical characteristics were obtained from all participants. Type D personality was assessed using the 14-item Type D Scale-Taiwanese version. Systolic blood pressure, diastolic blood pressure, and heart rate were measured at the end of baseline, anger recall, verbal, and recovery phases of an anger recall task. Analysis of covariance was used to examine differences in blood pressure and heart rate at the anger recall, verbal, and recovery phase between patients with or without type D personality.

Results: After adjusting for baseline measurements, sex, and age, systolic blood pressure ($p = 0.002$) and diastolic blood pressure ($p = 0.011$) at the recovery phase were significantly higher in the patients with type D personality. No significant differences in blood pressure or heart rate were observed in the anger recall or verbal phase between the two groups of patients.

Conclusions: The findings of this study support the notion that prolonged blood pressure recovery rather than high reactivity could be an underlying pathway linking type D personality and the risk of future cardiovascular events among patients with hypertension.

Key Words: Anger • Blood pressure • Hypertension • Type D personality

INTRODUCTION

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Type D, also known as distressed personality type, is defined as a joint tendency towards negative affectivity and social inhibition. People with high negative affectivity tend to experience negative emotions across time and situations, while those with high social inhibition often inhibit self-expression in social interactions.¹ The prevalence of type D personality is estimated to be 21% in the general population, and to range from 28% to 53% in patients with cardiac diseases.² Patients with type D personality have been reported to have an increased risk of a wide range of adverse health outcomes,³ including physiological hyperreactivity,⁴ immune activation,⁵ cogni-

tive dysfunction,⁶ depression,⁷ atrial fibrillation,⁸ and cardiovascular morbidity.^{9,10} Lin et al. showed that the somatic symptom of depression was associated with arterial stiffness as measured by noninvasive brachial-ankle pulse wave velocity among patients with coronary artery disease.¹¹ Arterial stiffness attributed to high blood pressure could therefore explain the association between type D personality and depression. In addition, an intrinsic cardiac autonomic nervous system has also been reported to play a significant role in the association between type D personality and atrial fibrillation.¹²

The exact mechanism relating type D personality to cardiovascular morbidity is still unknown. It is possible that individuals with type D personality have an increased risk of hypertension, as shown by a recent European cross-sectional study in which type D personality significantly increased the risk of hypertension by 2.5-fold after adjusting for well-recognized risk factors.¹³ Another cross-sectional study in the general Icelandic population also found that type D personality was associated with a significantly higher prevalence of hypertension.¹⁴ Elevated levels of cortisol and an imbalance of the autonomic nervous system have been proposed to be mediating factors in the association between type D personality and the increased risk of coronary heart disease.¹⁵⁻¹⁷ Kupper et al. examined the association between type D personality and hemodynamic and autonomic responses to the cold pressor test in healthy undergraduate students. They found that type D personality was associated with exaggerated α -adrenergic vasoconstriction and pressor response, and that this may increase the risk of hypertension later in life.¹⁷ On the other hand, another study on healthy young men found that type D personality was associated only with an enhanced cardiac output response to a mental arithmetic stressor, but not heart rate, blood pressure or peripheral resistance.¹⁸

It should be noted that the stressors used in previous studies were often mental arithmetic tasks, which may not fully trigger negative emotions and irritability that are measured by type D personality traits. Therefore, we used an anger recall task instead of a mental arithmetic stressor in this study to provoke anger. The main objective of this study was to investigate blood pressure reactivity to anger recall in hypertensive patients with or without type D personality.

MATERIALS AND METHODS

Participants

Outpatients from the Division of Cardiology of a regional hospital in southern Taiwan were consecutively recruited for this study. The inclusion criteria were: (a) age between 30 and 70 years; and (b) systolic blood pressure ≥ 140 mmHg and/or diastolic blood pressure ≥ 90 mmHg or taking anti-hypertensive medications. The definition of hypertension in this study was in line with blood pressure targets recommended by the 2017 updated guidelines of the Taiwan Society of Cardiology and the Taiwan Hypertension Society. These guidelines recommend blood pressure targets of systolic blood pressure < 140 mmHg and diastolic blood pressure < 90 mmHg, based on traditional office blood pressure measurements, for patients under 75 years of age and without diabetes, coronary heart disease, or chronic kidney disease.¹⁹

The exclusion criteria included: mental disorders, severe physical illnesses (such as coronary heart disease, congenital heart defects, congestive heart failure, cancer, stroke, or diabetes), dementia, Parkinson's disease, thyroid diseases, immune diseases, chronic kidney disease (stage 3-5), and liver cirrhosis.

The study protocol was approved by the Institutional Review Board of the study hospital. Informed consent was obtained from all participants before the study.

Experimental protocol

The participants were instructed to refrain from smoking and consuming caffeinated beverages and alcohol three hours prior to the start of the experiment. At the start of the experiment, the participants were asked to complete a questionnaire on their basic characteristics (age, sex, educational level, smoking, use of alcohol, and exercise). Data on the use of medications were obtained from the medical records of the participants. An anger recall task^{20,21} was then administered to the participants in a sound-attenuated and temperature-controlled room. The anger recall task consisted of four phases: (a) a five-minute baseline phase, wherein the participants were relaxed and comfortably seated; (b) a five-minute anger recall task, wherein the participants were asked to recall an anger event that occurred in the past six months and continued to anger them; (c) a five-minute verbal phase, wherein the participants were asked to verbally

describe the anger event; and (d) a five-minute recovery phase, wherein the participants were relaxed and seated comfortably. The instructions for the anger recall task were displayed on a computer monitor located in front of the participants.

Measurements

Type D personality was assessed using the 14-item Type D Scale-Taiwanese version (DS14-T),²² originally developed by Denollet.² The DS14 consists of two subscales, negative affectivity and social inhibition, each of which contains seven items with a 5-point Likert scale (0 = false to 4 = true). A standard cut-off score of ≥ 10 on both subscales is used to define the presence of type D personality. The original DS14 has been shown to have good psychometric properties (Cronbach $\alpha = 0.88$ and 0.86 ; 3-month test-retest reliability = 0.72 and 0.82 for negative affectivity and social inhibition, respectively).² The DS14-T has also demonstrated good internal consistency (Cronbach $\alpha = 0.86$ and 0.79), with factor analyses confirming the two-factor model of the type D construct.²²

Systolic blood pressure, diastolic blood pressure, and heart rate of the patients were recorded at the end of each of the four phases of the anger recall task using a vTRUST-701HD digital handheld non-invasive blood pressure monitor (BioCARE, Taoyuan, Taiwan). As a validity check, the participants were asked to report their emotions at baseline and at the anger recall phase using a checklist. The checklist was administered immediately after the baseline phase and again after the recovery phase. The checklist consisted of five terms (happiness, disgust, surprise, sadness, and anger) and the response format was based on a 5-point Likert scale, with a higher score indicating stronger feeling.

Statistical analysis

Group differences in demographic and clinical characteristics were compared using the t-test or Fisher's exact test, as appropriate. The paired t-test was used to assess differences in the five emotions experienced by the participants at baseline and anger recall phase. In addition, analysis of covariance was used to examine differences in systolic blood pressure, diastolic blood pressure, and heart rate during the anger recall phase, verbal phase, and recovery phase between the two groups, adjusting for the mean age, male sex, and their respective

measurements at the baseline phase.

The sample size of the study was estimated based on our pilot data with an expected difference of 10 mmHg in systolic blood pressure at the recovery phase between type D and non-type D patients, with a standard deviation of 12 mmHg at a power of 80%. An estimated sample size of 46 patients was required. However, due to various constraints including time and the availability of participants, 41 patients were finally recruited into the study. All analyses were performed using the IBM SPSS software package version 24.0 (SPSS Inc., Chicago, IL, USA).

RESULTS

The mean age of the 41 patients with hypertension enrolled in this study was 57.1 years (SD = 7.2 years, range = 38-69 years), of whom 56% were male. The proportion of patients classified as having type D personality was 34%. There were no significant differences between the patients with and without type D personality in sex, educational level, smoking, alcohol use, exercise, and baseline levels of systolic blood pressure, diastolic blood pressure, and heart rate (Table 1).

Significant changes in the emotion of the participants were observed (Table 2). At the anger recall phase, a feeling of happiness was significantly less intense compared with that at baseline. Conversely, feelings of disgust, surprise, sadness, and anger were all significantly more intense at the anger recall phase compared with the baseline phase. This result showed that the anger recall task was able to elicit anger in the participants.

The results of analysis of covariance comparing the least squares adjusted between the participants with and without type D personality are shown in Table 3. The adjusted mean was significantly higher in those with type D personality at the recovery phase for both systolic ($p = 0.002$) and diastolic blood pressure ($p = 0.011$).

DISCUSSION

The current study examined the association between type D personality and blood pressure reactivity to an anger recall task. The results showed that the adjusted means were significantly higher in the participants with

Table 1. Demographic and clinical variables of hypertensive patients (n = 41)

Variable	Total (n = 41)	Type D personality		p value
		Yes (n = 14)	No (n = 27)	
Mean age (SD), years	57.1 (7.2)	56.2 (5.7)	57.6 (7.9)	.577
Sex				.322
Male	23 (56.1)	6 (42.9)	17 (63.0)	
Female	18 (43.9)	8 (57.1)	10 (37.0)	
Educational level				.322
Junior high school or below	18 (43.9)	8 (57.1)	10 (37.0)	
Senior high school or above	23 (56.1)	6 (42.9)	17 (63.0)	
Smoking	8 (19.5)	2 (14.3)	6 (22.2)	.692
Alcohol use	4 (9.8)	2 (14.3)	2 (7.4)	.596
Exercise	25 (61.0)	7 (50.0)	18 (66.7)	.332
Medication use				
Beta-blockers	24 (58.5)	8 (57.1)	16 (59.3)	> .999
Calcium antagonists	20 (48.8)	4 (28.6)	16 (59.3)	.100
Diuretics	4 (9.8)	0 (0)	4 (14.8)	.280
ACEI	7 (17.1)	4 (28.6)	3 (11.1)	.205
ARB	19 (46.3)	6 (42.9)	13 (48.1)	> .999
Vasodilators	4 (9.8)	1 (7.1)	3 (11.1)	> .999
Mean type D personality score (SD)	19.3 (10.2)	31.6 (5.5)	12.9 (4.6)	< .001
Mean SBP at baseline (SD), mmHg	139.2 (15.2)	140.3 (19.5)	138.7 (12.8)	.745
Mean DBP at baseline (SD), mmHg	83.4 (10.8)	82.3 (14.1)	83.9 (9.0)	.658
Mean heart rate at baseline (SD), BPM	68.8 (10.3)	69.2 (13.7)	68.6 (8.2)	.879

ACEI, angiotensin-converting-enzyme inhibitor; ARB, angiotensin II receptor blocker; BPM, beats per minute; DBP, diastolic blood pressure; SBP, systolic blood pressure; SD, standard deviation.

Values are n (%) unless otherwise specified.

p values were obtained by t-test or Fisher's exact test, as appropriate.

Table 2. Emotion experienced at baseline and anger recall phase of an anger recall task in hypertensive patients

Emotion	Baseline phase	Anger recall phase	Differences	p value
Happiness	2.90 (1.36)	1.27 (1.52)	1.63 (1.62)	< .001
Disgust	0.37 (0.92)	2.49 (1.75)	2.12 (1.70)	< .001
Surprise	0.49 (1.12)	1.58 (1.77)	1.10 (1.70)	< .001
Sadness	0.27 (0.78)	2.32 (1.71)	2.05 (1.66)	< .001
Anger	0.12 (0.64)	3.17 (1.32)	3.05 (1.34)	< .001

p values were obtained by paired t-test.

Values are scores obtained from a 5-point Likert scale checklist. A higher score indicates stronger feeling.

type D personality at the recovery phase for both systolic and diastolic blood pressure. In other words, a longer time was required to recover to baseline level in the participants with type D personality. However, no differences were observed during the anger recall phase and verbal phase between the two groups of patients. Previ-

ous research has pointed out the importance of examining recovery in addition to reactivity alone in anger provocation research.²³ In fact, recovery of blood pressure after stress has been suggested to be a better predictor of a long-term increase in blood pressure than acute reactivity to stressors. Steptoe and Marmot reported an adjusted odds ratio of 3.50 for an increase in systolic blood pressure ≥ 5 mmHg over a 3-year period in individuals with poor compared with effective post-stress recovery of systolic blood pressure.²⁴ Radstaak et al. proposed that blood pressure recovery was impeded by the negative effects of manipulation and rumination.²⁵

A higher prevalence of hypertension among patients with type D personality has been reported in a pan-European population,²⁶ general Icelandic population,¹⁴ Israeli population,²⁷ and Italian population.¹³ However, few studies have focused only on patients with hypertension. The proportion of hypertensive patients classified as having type D personality was 34% in this study. This fig-

Table 3. Analysis of covariance of the effect of an anger recall task on blood pressure and heart rate in hypertensive patients with or without type D personality

Variable	Adjusted mean*		Adjusted mean difference (95% CI)	p value
	Type D personality			
	Yes	No		
Systolic blood pressure (mmHg)				
Anger recall phase	139.4	137.8	1.6 (-1.3, 4.5)	.270
Verbal phase	160.3	154.1	6.2 (-4.3, 16.7)	.238
Recovery phase	152.5	143.4	9.1 (3.5, 14.7)	.002
Diastolic blood pressure (mmHg)				
Anger recall phase	84.0	83.4	0.6 (-1.4, 2.7)	.535
Verbal phase	96.4	94.7	1.7 (-4.3, 7.8)	.567
Recovery phase	91.0	87.0	4.0 (1.0, 7.1)	.011
Heart rate (BPM)				
Anger recall phase	69.7	68.9	0.8 (-0.4, 2.0)	.176
Verbal phase	72.8	72.5	0.3 (-1.8, 2.4)	.800
Recovery phase	69.0	68.3	0.7 (-0.9, 2.2)	.386

BPM, beats per minute; CI, confidence interval.

* Values were least squares adjusted for mean age (57.1 years), sex (male), and baseline values of systolic blood pressure (139.2 mmHg), diastolic blood pressure (83.4 mmHg), and heart rate (68.8 BPM), as appropriate.

ure is similar to the 34.2% reported in European patients with coronary artery disease,²⁸ the 35.8% reported in Iranian patients with myocardial infarction,²⁹ and the 31.4% reported in Chinese patients with coronary heart disease.³⁰

Research on blood pressure reactivity to mental stress tasks in individuals with type D personality has produced mixed results. A study on 101 undergraduate students in the Netherlands found an association between type D personality and an exaggerated blood pressure response to cold stress. However, no significant differences were observed between students with or without type D personality when challenged with a mental (arithmetic and speech) stress task.¹⁷ Another study on 173 Canadian undergraduate students using a stress protocol involving a mental arithmetic task with harassment showed that type D personality remained a significant predictor of systolic blood pressure, diastolic blood pressure, and heart rate, even after controlling for a number of traditional risk factors.⁴ However, in a study of 84 healthy young adults, type D men exhibited significantly higher cardiac output but not heart rate or blood pressure during the mental arithmetic stressor phase compared to non-type D men.¹⁸ In addition, type D personality has been shown to be predictive of blunted cardiovascular reactivity to multitasking stress in healthy young individ-

uals.³¹ Among patients with heart failure, type D personality has also been associated with low cardiovascular reactivity, including heart rate and blood pressure, to acute mental stress.³² On the other hand, our study, which used an anger recall task instead of an arithmetic task, demonstrated significantly different blood pressure reactivity in patients with type D personality. The least squares adjusted differences were observed only at the recovery phase but not the anger recall phase or verbal phase. The discrepancy between our study and previous research could be attributed to the age of the study participants. Previous studies have focused mainly on healthy young people, whereas the participants in the present study had a mean age of 57 years. It is likely that old people can less readily recover from anger than young people because of the decline in cardiac autonomic function.³³

Another plausible explanation for the discrepancy between our study and previous research is the use of different stressors. The type D personality construct can differentially relate to physiology depending upon the nature of the stress. Bibbey et al. found that individuals with type D personality exhibited significantly higher cardiovascular responses, including both heart rate and blood pressure, when challenged with a social evaluative threat compared with a nonsocial threat.¹⁶ It has

also been proposed that individuals with type D personality may have a cognitive bias towards interpreting ambiguous social situations as significantly more distressing, which would increase their vulnerability to perceived social stress.³⁴ Bibbey et al. further proposed that individuals with type D personality may show diminished cardiovascular and cortisol reactivity when faced with non-social stress exposure, but exaggerated responses under conditions of high socially evaluative threat. This pattern of stress response could be attributed to dysregulation of the sympathetic-adrenal-medullary system and hypothalamus-pituitary-adrenal axis.¹⁶ Kupper et al. classified stressors into two main types: active stressors, such as mental arithmetic or public speech tasks, and passive stressors, such as cold pressor or other painful stimuli. While active stressors are generally associated with increased systolic blood pressure and heart rate, passive stressors are related to a higher diastolic blood pressure. This observation suggests that active behavioral tasks are associated with the β -adrenergic pathway, whereas passive stressors generally elicit an α -adrenergic response.¹⁷ Moreover, Gerin et al. showed that angry ruminations were associated with prolonged blood pressure recovery.³⁵ Glynn et al. also reported that the emotional nature of a stressor could affect the duration of blood pressure recovery. In addition, whereas emotional tasks were associated with delayed recovery, non-emotional tasks were associated with rapid recovery. The association between emotional stressors and delayed blood pressure recovery maybe explained by rumination, which recreates the original emotional stressor in one's mind.³⁶

The results of this study should be interpreted in light of its limitations. First, this study was based on a relatively small sample size of hypertensive patients from a single center. However, the study had sufficient power to detect significant differences in the recovery phase of the anger recall task between patients with and without type D personality. Second, anger was elicited under laboratory conditions using an anger recall task, and the response may not be representative of stress experienced in real-life situations. Third, a number of factors, such as arterial stiffness, metabolic syndrome, and body mass index that have been shown to be associated with type D personality may also influence impaired blood pressure recovery. However, mea-

surements for these variables were not available in our study, and therefore their potential confounding effects could not be evaluated and adjusted accordingly.

CONCLUSIONS

In conclusion, the hypertensive patients with type D personality in this study had significantly higher adjusted mean systolic and diastolic blood pressure at the recovery phase of anger recall. The findings of this study support the notion that a prolonged blood pressure recovery rather than high reactivity could be an underlying pathway linking type D personality and a high risk of cardiovascular morbidity and mortality among patients with hypertension. Additional studies are warranted to further clarify the role of blood pressure recovery in the risk of future cardiovascular events among individuals with type D personality.

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