Relationship between baroreceptor reflex function and end-organ damage in spontaneously hypertensive rats

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Shan, Zheng-Zheng, Sheng-Ming Dai, and Ding-Feng Su. Relationship between baroreceptor reflex function and end-organ damage in spontaneously hypertensive rats. Am. J. Physiol. 277 (Heart Circ. Physiol. 46): H1200–H1206, 1999.—The purpose of this study was to further illustrate the relationship between baroreceptor reflex sensitivity (BRS) and hypertensive end-organ damage (EOD) and to test the hypothesis that impairment of BRS aggravates EOD in hypertension. We studied baroreflex-mediated changes in heart rate (expressed as baroreceptor sensitivity to heart rate control [BRS\textsubscript{HR}]) and blood pressure (expressed as baroreceptor sensitivity to blood pressure control [BRS\textsubscript{BP}]) in spontaneously hypertensive rats (SHR) and Wistar-Kyoto rats (WKY) that were used as controls, both at the age of 50–52 wk. Rats were also instrumented to record BP, HR, and BP variability (BPV) in the conscious, unrestrained state. In SHR compared with WKY, BP and BPV were significantly increased, whereas BRS\textsubscript{HR} and BRS\textsubscript{BP} were significantly decreased. SHR had remarkable EOD when compared with WKY (EOD score: 6.3 ± 2.5 vs. 2.9 ± 0.8, P < 0.01). Univariate regressive analysis demonstrated that EOD score was increased with BP and BPV and decreased with BRS. In multivariate analysis, EOD score was predicted by greater systolic BP and lower BRS and HR variability. These results indicate that BRS is negatively related to BPV and EOD score, and impaired BRS might be one of the major causes for hypertensive EOD.

Baroreflex sensitivity of blood pressure control; blood pressure variability; heart rate variability; hypertension

Baroreceptor reflex activity is an important factor in the homeostatic regulation of the cardiovascular system. The main purpose of this reflex is to maintain blood pressure (BP) within certain limits over a short time frame (11, 13). Baroreflex plays an important role in maintaining the stability of BP.

In mammals, opening of the baroreflex loop leads to a remarkable instability of BP, which is termed blood pressure variability (BPV) (26). A consistent feature in many species is that interruption of the baroreceptor reflex by different methods such as sinoaortic denervation (SAD) can lead in conscious animals to increase in BPV regardless of whether BP remains elevated (3). Thus there is an expected inverse relationship between the baroreceptor reflex sensitivity (BRS) and BPV. However, the lack of linear correlation between BRS [estimated as slope of the relationship between systolic BP and heart period (HP)] and BPV was reported previously (30). Therefore, controversy still remains as to the relationship between BRS and BPV. Recently, a new method of detecting the sensitivity of the baroreceptor controlling BP (BRS\textsubscript{BP}) was established in our laboratory (31), whereas, to the best of our knowledge, the relationship between BRS\textsubscript{BP} and BPV (especially in the hypertensive models) has not been clearly demonstrated.

Although the treatment of hypertension is focused on the BP level, the variability per se and ability to buffer changes of BP may also be of considerable importance. It is well known that both in hypertensive and normotensive patients and animals, BP shows a typical circadian fluctuation; BP is not a constant variable. BPV becomes greater in hypertensive than in normotensive subjects (20), and clinical studies have shown that hypertensive patients with the greatest 24-h variability exhibit a greater rate and severity of injury of organs like heart and kidney that are key players in the development of hypertension (20, 21). These studies demonstrated a positive relationship between BPV and the severity of hypertensive end-organ damage (EOD) (20, 21). Baroreflex dysfunction and its impact on the occurrence and development of hypertension have appealed more and more to the interest of investigators. Concerning the baroreflex, recently it was highlighted that measurement of BRS could yield important prognostic information about myocardial ischemia, additional to that provided by clinical markers (27). To our knowledge, the interrelation between baroreflex function and the severity of hypertensive EOD has received little attention to date.

The purpose of the present study was 1) to determine further the relationship between BPV and BRS [both heart rate (HR) control and BP control], 2) to verify the relationship between BPV and severity of EOD in spontaneously hypertensive rats (SHR) by morphological study, and 3) to test the hypothesis that the impairment of baroreflex function aggravates EOD in hypertension.

Materials and Methods

Animals

Adult male SHR (50–52 wk of age) were purchased from the Shanghai Institute of Hypertension. Sex- andagematched Wistar-Kyoto rats (WKY) were used as control rats. Rats were housed with controlled temperature (23–25°C) and lighting (8:00–20:00 light, 20:00–8:00 dark) and with free access to standard chow and tap water.

Recording of Arterial Pressure in Conscious Rats

Rats were anesthetized with ketamine (50 mg/kg ip) and diazepam (5 mg/kg ip). A floating polyethylene (PE) catheter
that consisted of a piece of heat-stretched PE-10 fused to a PE-50 extension was inserted into the lower abdominal aorta via the left femoral artery. Another catheter was brought into the left femoral vein for intravenous injections. The free ends of the cannulas were tunneled subcutaneously and exteriorized at the top of the skull. A light, flexible metal coil attached to the rats by a linen jacket protected all catheters. The coil was attached to an overhead, lightly counterbalanced arm to ensure minimum tension. After cannulation, the rats were placed in cages for 2 days of recovery. On the day of an experiment, a rat was placed in an individual cage, and the aortic catheter was connected to a BP transducer via a rotating swivel that allowed the rat to move freely. The rats were allowed a 14-h habituation period before the experiments were started. BP and HP signals were digitized and processed on-line using a data acquisition system assembled on a microcomputer equipped with an analog-to-digital converter board. Systolic blood pressure (SBP), diastolic blood pressure (DBP), and HR were calculated according to beat-to-beat pulsatile pressure wave.

Estimation of Cardiovascular Variability

The method of estimating 24-h BPV is to calculate the standard deviation (SD) of the 24-h average BP (20, 21). Briefly, a day (24 h) was divided into 48 0.5-h segments. Measurement of 24-h BPV was determined as the average of the SD of each individual 0.5-h segment (variability "within" 0.5-h segments) and the SD of the mean of all 0.5-h mean values across 24 h (variability "between" 0.5-h segments). BPV within a 0.5-h segment was then defined as a "short-term" BPV, and BPV between 0.5-h segments was defined as a "long-term" BPV. Variability of HP was used to represent HR variability (HRV); the calculation of HRV was similar to the calculation of BPV.

Baroreflex Sensitivity Measurements

BRS of HR control measurement. BRS of HR control (BRS_{HR}) was determined according to the method reported by Smyth et al. (28) with slight modifications. Briefly, a bolus intravenous injection of phenylephrine (Sigma) was used to induce an elevation of SBP; the dose of phenylephrine was adjusted to raise SBP >15 mmHg and <40 mmHg. HP (beat-to-beat interval) was then plotted against SBP with five shifts for linear regression analysis (30); the SBP-HP slope was then expressed as BRS_{HR} (Fig. 1). The results of two to three injections were averaged.

BRS of BP control measurement. Determination of BRS of BP control (BRS_{BP}) was performed using the method reported by Su et al. (31). Briefly, BRS_{BP} was estimated by comparing the pressor responses (area under pressor curves (AUC)) to 5 µg/kg of phenylephrine before and after autonomic blockade with intravenous injection of guanethidine (Sigma) and methylatropine (Sigma; Fig. 2). The protocols are as follows. 1) The pressor responses of a bolus intravenous injection of phenylephrine (5 µg/kg) were determined, and the AUC was presented as A_{1}. 2) Vagal blockade was performed by intravenous injection of methylatropine (1 mg/kg). Ten minutes later, the pressor response to phenylephrine was determined, and the AUC was presented as A_{2}. 3) Sympathetic blockade was performed with an intravenous injection of the ganglionic blocker guanethidine (10 mg/kg). Forty-five minutes later, a half-dose of guanethidine (5 mg/kg) was given. Thirty minutes later, the pressor response to phenylephrine was determined, and the AUC was presented as A_{3}. 4) After both sympathetic and parasympathetic blockade were accomplished, the pressor response to phenylephrine (5 µg/kg) was determined again, and the AUC was presented as A_{4}. 5) The level of BRS_{BP} was demonstrated as the following: BRS_{BP} (%) = (A_{4} - A_{1})/(A_{2} × 100. 6) Within the efferent pathway of BRS_{BP}, the sympathetic or vagal component could be estimated after sympathetic blockade with guanethidine or vagal blockade with methylatropine, respectively. The sympathetic component of BRS_{BP} efferent pathway was given by BRS_{BP-sym} (%) = (A_{3} - A_{1})/(A_{2} × 100; the vagal component of BRS_{BP} efferent pathway was given by BRS_{BP-vag} (%) = (A_{2} - A_{1})/(A_{2} × 100.

Morphological Observations

At the end of the observation periods, rats were allowed a 1-wk recovery period and then were killed by intravenous injection an overdose of KCl (1 mol/l) so that the heart beating stopped at the diastolic phase. Heart, aorta, mesenteric artery, kidney, and brain were rapidly excised for gross detection. The organs were then fixed by immersion in buffered saline solution with 10% formaldehyde for a month. The tissues were then embedded in paraffin after dehydration. Five-micrometer-thick sections were made and stained with hematoxylin and eosin for light microscopic measurements.

A semiquantitative score was used to evaluate the degree of damage according to the method reported previously (4,10) with some slight modification. The criteria for scoring were determined based on both gross and microscopic determinations of the various organs (Table 1). All the scoring was performed by another group of researchers who were not aware of the groups and strains of the animals.

Statistical Analysis

All data are expressed as means ± SD. The means of each variable in SHR and WKY groups were compared by unpaired Student’s t-test. The interrelationship between BRS and BPV was assessed by classic univariate correlation analysis. Stepwise multiple-regression analysis was performed to study the independent effect of BRS_{HR}, BRS_{BP}, or other hemodynamic variables on EOD score, by considering variables initially identified as having statistically significant relations to the
EOD scores in univariate analysis. F to enter and F to remove were set to $P < 0.05$ and $P < 0.10$, respectively. Stability of the estimates of regression coefficients was assessed using collinearity diagnostics. A two-tailed value of $P < 0.05$ was considered statistically significant.

RESULTS

Baseline Hemodynamic Parameters in Conscious Rats

As shown in Table 2, the 24-h average SBP, DBP, and mean arterial pressure (MAP) of SHR were significantly increased over those of WKY. No significant difference was found between HR of the two strains. The variability of SBP and DBP (both long term and short term) was significantly higher compared with that of WKY. In SHR, short-term HRV was remarkably lower than that of WKY, but no difference existed between long-term HRV of the two strains (Table 2).

BRS

SHR had significantly lower baroreflex function than WKY, as shown in Table 3. After a bolus phenylephrine injection, nearly no bradycardia could be found when BP was obviously elevated in SHR, but a significant bradycardia occurred when BP was increased in WKY; therefore, BRS$_{HR}$ of SHR was significantly lower than that of WKY. BRS$_{BP}$ of SHR was also lower than that of WKY. After selective autonomic blockade with guanethidine or methyleratropine, component analysis showed that the sympathetic component was predominant whereas the vagal component was relatively weak in the two strains. Both sympathetic and vagal components in SHR were found to be significantly decreased when compared with those in WKY (Table 3).

Correlation Between BRS and Variability of BP and HR

As shown in Table 4, in WKY, there existed an inverse correlation between BRS$_{BP}$ and short-term variability of SBP and DBP, whereas no correlation was found between BRS$_{HR}$ and any hemodynamic parameters of WKY. In SHR, BRS$_{BP}$ was inversely related to long-term and short-term BPV, whereas BRS$_{HR}$ was only related to long-term variability of DBP. When the population of WKY and SHR was considered as a whole, BRS$_{BP}$ was inversely related to all the parameters of BPV, whereas BRS$_{HR}$ was only negatively related to long-term variability of SBP and DBP. The linear regression coefficients ($r$) between BRS$_{BP}$ and BPV were greater than those between BRS$_{HR}$ and BPV. Except for a significant positive correlation between BRS$_{BP}$ and short-term HRV, neither BRS$_{HR}$ nor BRS$_{BP}$ was related to HR or long-term HRV (Table 4).

Morphological Changes and EOD Scores

EOD scores were estimated in SHR and WKY by researchers who were not aware of the groups and...
animal strains. SHR had significantly higher scores than those of WKY, which suggested that significant EOD occurred in SHR compared with WKY (Table 5).

SHR had remarkable cardiovascular and renal injury compared with WKY. Fibrohyalinosis and thickness of arteriolar and small arterial walls in various organs were the most consistent vascular changes in SHR. In addition, significant renal arteriolar lesion and glomerular injury such as ischemia with collapse of the tuft occurred in SHR. Myocardial hypertrophy with thickening of myocardial fibers could also be found in most SHR. Focal bleeding of the brain could be seen in 1 of 40 SHR. Aortic atherosclerosis was not found in SHR.

Univariate Correlation Analysis Between EOD Score and Cardiovascular Variables

The relationship between BRS, BP, HR, BPV, and HR variability and EOD score in SHR (n = 40) was evaluated (Table 6). EOD score was inversely related to BRS_HR and BRS_BP. A positive linear relationship was also found between SBP and EOD score and between DBP and EOD score. As to the correlation between BPV and EOD score, only long-term SBP variability and DBP variability were positively related to EOD score, and no statistically significant correlation was found between short-term BPV and EOD score. EOD score was related to neither HR nor long-term HRV, but the relationship between short-term HRV and EOD score reached a statistically significant level.

Stepwise Multiple-Regression Analysis

The relative dependencies of EOD scores on BRS and other cardiovascular variables were assessed by stepwise multiple-regression analysis. When BRS was represented by BRS_HR, EOD score was independently associated with higher SBP (β = 0.430, P < 0.001), lower BRS_BP (β = −0.447, P < 0.001), and lower short-term HRV (β = −0.211, P < 0.001). The regression equation was EOD score = (−4.80 × BRS_HR) + (3.37 × SBP) − (3.52 × HRV) + 1.14 ± 1.08 (multiple R² = 0.81, P < 0.0001). When BRS was represented by BRS_BP, EOD score was independently associated with higher SBP (β = 0.335, P < 0.001), lower BRS_BP (β = −0.501, P < 0.001), and lower short-term HRV (β = −0.218, P < 0.001). The regression equation was EOD score = (−1.28 × BRS_BP) + (2.57 × SBP) − (3.63 × HRV) + 0.56 ± 1.07 (multiple R² = 0.83, P < 0.0001). The standardized equations were expressed as follows: EOD score_a = (−0.447 × BRS_HR) + (0.430 × SBP) − (0.211 × HRV) and EOD score_b = (−0.501 × BRS_BP) + (0.335 × SBP) − (0.218 × HRV). The relative merits of BRS, SBP, and HRV as predictors of EOD could be compared directly by performing a comparison among the standardized partial regression coefficients (β). As a result, the contribution of BRS to EOD seemed the greatest, the effect of SBP was the second greatest, and the effect of short-term HRV was the slightest. DBP and long-term BPV were not entered into the model.

DISCUSSION

In the present study, we chose a pharmacological method (autonomic blockade with intravenous injection of guanethidine and methyldopa) to test the changes of the efferent limb of the baroreflex in hypertension, namely BRS_BP. SHR had significantly lower BRS_BP compared with WKY. Component analysis showed that both sympathetic and parasympathetic efferent responses were significantly decreased in SHR compared with those in WKY. The results suggested that in SHR the established hypertension was associated with a significantly lower BRS, caused by the decreased sensitivity of the efferent limb in the reflex arc. Moreover, we also found that the sympathetic component of the efferent limb was predominant in both SHR and WKY, whereas the vagal component was rather weak in the two strains. This suggests that in rats, the baroreflex function of BP control is performed mainly through the sympathetic efferent to influence the tonicity and compliance of the vessels and thereby regulate BP. The baroreflex function of HR control is mediated mainly through the vagus. Support for our conclusion comes from the results of another study in
which the vagal component of BRSHR was predominant in Lyon rats (17). The impaired function of the sympathetic effector of the baroreflex may be associated with increase in BPV, because evidence has been presented that the sympathetic nervous system may not only play a permissive role in BPV by sustaining vascular tone but may directly generate part of the BPV (11, 32). It is well known that 24-h BP is characterized by large, spontaneous variations. Controversy still remains as to the relationship between BRS and BPV. In the present study we demonstrated that BRSBP was negatively related to BPV, which suggests that increased BPV may result from impaired BRS. Supportive data obtained from SAD rats demonstrated that BPV of SAD rats whose baroreflex function was impaired was significantly increased while 24-h averaged BP remained the same as that of sham-operated rats that had an intact baroreflex (22). Several studies also showed that there was an inverse relationship between BRSHR and short-term BPV (7, 8, 26). However, other data indicated that there was only a weak correlation between BRSHR and BPV of Lyon rats, and atropine could not increase BPV although it almost completely abolished BRSHR, so the investigators concluded that BRSHR was not linearly related to BPV (30). Potential explanations for the conflict may be as follows. 1) The method described originally by Smyth et al. (28) to measure BRS was developed for use in humans. With one bolus of phenylephrine, systolic pressure of successive arterial pulses is plotted in that method against each pulse interval that begins with the next beat. This can be done in humans, because the latency of the cardiac reflex response in humans is 0.5–2 s; normal HR in humans approximates 1–1.5 beats/s, correlating with a 0 or +1 phase shift to estimate BRS (29, 30). In rats, however, HR is 6–8 beats/s; this means that phase shifts of +4 to +10 may have to be used to obtain optimal correlation. Therefore, different data may be obtained because of methodological differences. 2) Studies that were conducted in adult rats of different strains and ages may not be comparable. 3) HR-BP interactions are complex. The principal determinant of BP is vascular resistance rather than HR. BRSHR, elicited by a pressor (and sometimes a depressor) agent, has been measured by innumerable investigators in countless humans and animals with hypertension, but BRSHR measurement alone could not answer the question of how the properties of the baroreceptor reflexes that control BP are altered. The inability of the technique to measure baroreflex control of vascular resistance is the deficit of BRSHR. Ludbrook (18) once suggested that there must be a better way to describe the capacity of the baroreflex to control BP in humans or conscious animals, the method imposing a standardized disturbance that would alter BP with the input from the baroreceptors intact or absent.

We adopted a new method to detect BRS of BP control that could characterize directly the property of the baroreceptor to control BP, not only the magnitude of the BP change but also the time taken for returning to normal values. The method involves an evaluation degree of damage according to observation of morphological changes in heart, aorta, mesenteric artery, and brain. See Table 1 for scoring criteria. The EOD score is a semiquantitative semiquantitative score used to evaluate degree of damage according to observation of morphological changes in heart, aorta, mesenteric artery, and brain. See Table 1 for scoring criteria.

Table 5. End-organ damage score in adult SHR and WKY (50–52 wk of age)

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<th>EOD Score</th>
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<td>WKY</td>
<td>15</td>
<td>2.9 ± 0.8</td>
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<tr>
<td>SHR</td>
<td>40</td>
<td>6.3 ± 2.5†</td>
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Values are means ± SD; n, no. of rats. EOD score: end-organ damage score. EOD score was a semiquantitative score used to evaluate degree of damage according to observation of morphological changes in heart, aorta, mesenteric artery, and brain. See Table 1 for scoring criteria. †P < 0.01 compared with WKY.

Table 6. Linear regression coefficient between EOD score and other cardiovascular variables in conscious adult SHR (50–52 wk of age)

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<th>SBP</th>
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r, Linear regression coefficient.
baseline. Neither in WKY nor in SHR could we find a close correlation between BRS_{HR} and BPV, which appeared to be in agreement with the previous reports (30). In contrast with BRS_{HR}, BRS_{BP} was much more closely related to BPV in the present study. Although we found that the correlation between BRS and BPV in WKY rats seemed relatively weak, this may be caused by the small number of observations. Therefore, the data obtained from the whole group including both WKY and SHR were analyzed, and we found a close inverse relationship between BRS_{BP} and all the parameters of BPV, whereas BRS_{HR} seemed weakly related to BPV. The regression coefficient (r) between BRS_{BP} and BPV was greater than that between BRS_{HR} and BPV, so BRS_{BP} might be a more ideal index for expressing baroreflex function. In addition, neither HR nor HRV in our present study was closely related to BRS, which suggested that baroreceptors mainly answered for the afferent input of rise of BP rather than the changes in HR. Thus the present data appeared to be consistent with the prevailing concept that baroreflex function is mainly influenced by the level of BP (11, 18, 25).

Epidemiologic studies have documented high BP as a major risk factor for cardiovascular morbidity and mortality, which seems to be related to the detrimental effects of hypertension on certain end organs. The major end organs that suffer from sustained hypertension are the heart, aorta, small arteries, kidneys, and brain. Persistent inappropriate BP elevation leads to development of left ventricular hypertrophy, progressive atherosclerosis, and structural changes in the arterial tree. These changes result in clinical manifestations such as ischemic cardiac events, renal failure, and peripheral vascular insufficiency. However, BP alone is not the “final” determinant of hypertensive EOD. Knorr and co-workers (15), who tested the influences of different antihypertensive drug classes on survival in animal models, confirmed this concept. They found that captopril could markedly prolong survival, whereas dihydralazine and minoxidil could not and minoxidil even invariably increased heart weight and reduced survival, although all the agents could decrease BP. Many studies showed that the baroreflex function was impaired in both humans and experimental animals with chronic hypertension (11). It appeared that the baroreflex deficit may be caused by chronic development of hypertension. However, unsupportive data demonstrated that the baroreceptors in SHR had significantly lower sensitivity than those in WKY before the onset of hypertension (1, 27). Also, clinical research showed that people with a family history of hypertension have lower BRS than those without a family history, regardless of their BP levels (24). These results suggested that depression of BRS may be genetically determined.

Antihypertensive treatment of SHR with angiotensin-converting enzyme inhibitors could decrease BP to normotensive levels, but the impaired BRS remained (12). In rats with two-kidney, one-clip hypertension, removal of the hypertensive stimulus by unclipping of the renal artery could not ameliorate the baroreflex dysfunction; there was still a strong inverse relationship between BRS and the degree of cardiac hypertrophy (14). Baroreflex dysfunction was maintained despite elimination of the hypertension by simultaneous infusion of the vasodilator nitroprusside along with ANG II (6). Malpas et al. (19) found that after 7 wk of ANG II infusion, although hypertension remained, the gain of the baroreflex curve still was somewhat attenuated to the extent that it was not markedly different from that at the normotensive level. Therefore, decreased BRS is not dependent on elevated arterial pressure. Hypertensive EOD like cardiac hypertrophy was once proposed to be one of the major determinants of the reduced BRS; the thickening of the ventricular wall makes it less sensitive to physiological stimuli (12, 29). However, although cardiac hypertrophy developed after 7-wk ANG II infusion, its presence did not appear to be sufficient to produce a decrease in BRS (19). The impairment of BRS could still be found without cardiac hypertrophy in N^G^-nitro-L-arginine methyl ester-induced hypertensive rats (16). These results indicated that neither hypertension nor cardiac hypertrophy alone is sufficient to induce and maintain baroreflex deficit (2, 16, 19).

Our present study demonstrated a strong inverse correlation between BRS (both BRS_{HR} and BRS_{BP}) and EOD scores in SHR. However, this was still based on an association between two measured variables, and it should be noted that although the linear relationships between the variables were sought in the study, their different contributions to the degree of EOD were hard to define. Therefore, the results of stepwise multiple regression analysis were comparable with these relative effects of BRS and other cardiovascular variables on EOD. Comparing the standard partial regressive coefficients, we found that BRS, SBP, and short-term HRV had the greatest merit as predictors of EOD. Among the three variables, the effect of BRS on hypertensive EOD was the greatest and that of short-term HRV was the slightest. Therefore, our study raised the important possibility that the impaired BRS could aggravate hypertensive EOD. This was further supported by other studies in which surgical disturbance of the baroreflex function by sinoaortic denervation could result in myocardial hypertrophy (9) and renal morphological change (23). Although BPV was not entered into the equation, in fact, this is not in conflict with the results of univariate regression analysis. Although BPV was positively related to EOD, it was eliminated in stepwise multiple regressive analysis because it was a variable derived from BP and closely related to BRS and therefore was not considered as an “independent” variable. Considering HRV, we have confirmed that it was significantly decreased in SHR compared with WKY, which suggested a reduction in the vagal nerve activity; therefore, the resultant sympathetic hyperactivity may be involved in the EOD in hypertension. Thus newly developed centrally antihypertensive agents such as moxonidine, rilmenidine, etc. that act principally at rostral and ventrolateral medullary imidazoline receptors to markedly reduce peripheral sympathetic nerve activity and to increase cardiac vagal baroreflex
sensitivity provide a ideal profile of action for not only antihypertensive effects but restoration of baroreflex function in addition to reversal of end-organ injury in hypertension (5, 11, 33).

In summary, baroreflex sensitivity was significantly decreased in SHR compared with WKY. Using two methods of detecting BRS, we found that there was a very close negative correlation between BRSSP and BPV, whereas BRSSH was rather poorly related to BPV. BRSSP and short-term HRV were inversely related to EOD, whereas BP and BPV were positively related to EOD in SHR. Among the above variables, the merit of BRS as a predictor for hypertensive EOD was the greatest. In conclusion, BRSSP is an ideal index for evaluating baroreceptor function; BRS is negatively related to BPV and severity of EOD. Impaired baroreflex function might be one of the major causes that aggravates hypertensive EOD.

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REFERENCES


