Daily profile of baroreflex sensitivity and the variability of blood pressure in essential hypertensive patients

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Summary
1. We have monitored intra-arterial pressure continuously throughout the day and analysed every beat by computer.
2. Baroreflex sensitivity (ms/mmHg) was measured four times a day (07.00, 12.00, 17.00 and 20.00 hours) in seven patients and three times a day (07.00, 12.00 and 17.00 hours) in 23 patients. The diurnal variation of baroreflex sensitivity in individual patients was 0.5–3 ms/mmHg and was not consistent. Mean baroreflex sensitivity was reduced in hypertensive patients compared with normotensive subjects.
3. A negative correlation was seen between baroreflex sensitivity and the variability of systolic blood pressure.
4. Baroreflex sensitivity was well correlated with the variability of heart rate.

Key words: baroreflex sensitivity.

Introduction
It is accepted that the arterial baroreceptor reflex is important for preventing excessive pressure rises or falls in physical activity, mental stress or sleep. It is also well known that the baroreceptor reflex is reduced in hypertensive patients compared with normotensive subjects [1–3]. Cowley et al. [4] observed that there was a tremendous variation in arterial pressure in dogs whose baroreceptors had been denervated, compared with normal dogs, although the values for arterial pressure in the two groups of dogs were nearly identical. This fact showed the importance of the buffering function of the baroreceptor system in arterial pressure variance. It has also been reported that baroreflex sensitivity changes during the day and has a circadian rhythm in normotensive subjects [5]. In this study we attempted to clarify the influence of baroreceptor function on the variability of blood pressure and to see whether or not there was a diurnal variation in patients with essential hypertension.

Methods
Thirty patients were included in this study. All were mild to moderate essential hypertensives aged 19–68 years (42.0 ± 12.9, mean ± SD); 25 patients were males, and five were females. All were untreated inpatients on a diet containing 10–15 g of NaCl/day and each was in the recumbent position on a bed during the study except for the time of voiding and taking a meal.

A microcatheter was inserted percutaneously into the left brachial artery under local anaesthesia. The catheter was connected to a perfusion pump and to the miniature blood pressure instrumentation transducer (Gould Statham physiological pressure transducer P-50). Intra-arterial pressure was monitored continuously throughout the 24 h period with telemetry and was recorded on magnetic tape with an instrumentation tape recorder. Blood pressure signals were analysed beat by beat to obtain mean values and standard deviations for systolic, mean and diastolic blood pressures and those for heart rate were calculated by computer from pressure pulse interval time. Standard deviations and mean values obtained from the frequency distribution histogram of blood pressure and heart rate were used as indices of the variability of blood pressure and heart rate.

Baroreflex sensitivity was measured by the method of Smyth et al. [6]. In brief, bolus doses of phenylephrine were injected intravenously to produce a pressor response. Each measurement...
was repeated four or five times. Baroreflex sensitivity was calculated by the slope of the regression line relating the increase in pulse interval to the rise in systolic blood pressure. We recorded baroreflex sensitivity only if the $r$ value (correlation coefficient) between the R–R interval on ECG and systolic blood pressure was more than 0.8. Baroreflex sensitivity was measured four times a day (07.00, 12.00, 17.00 and 20.00 hours) in seven patients and three times (07.00, 12.00 and 17.00 hours) in 23 patients and compared with that in 24 normotensive subjects.

**Results**

Baroreflex sensitivity was reduced in all hypertensive patients ($4.7 \pm 2.5$ ms/mmHg) compared with the normotensive group ($16.6 \pm 6.3$ ms/mmHg). It fluctuated by a maximum of $0-5.3$ ms/mmHg in individual patients during the day. It was $5.2 \pm 1.8$ (07.00 hours), $5.7 \pm 4.5$ (12.00 hours) and $4.4 \pm 3.1$ ms/mmHg (17.00 hours) in 23 patients, $3.7 \pm 2.0$ (07.00 hours), $3.9 \pm 1.9$ (12.00 hours), $4.0 \pm 2.4$ (17.00 hours) and $4.2 \pm 2.1$ ms/mmHg (20.00 hours) in seven. These differences were not statistically significant, suggesting no consistent diurnal variation of baroreceptor function (Fig. 1).

Baroreflex sensitivity was inversely correlated with the variability of systolic blood pressure over 3 h around each measurement of it ($r = -0.462$, $P < 0.001$) and also over all the waking hours ($r = -0.476$, $P < 0.025$).

A negative correlation was seen between baroreflex sensitivity and the average systolic blood pressure ($r = -0.570$, $P < 0.005$) and also between baroreflex sensitivity and the average mean blood pressure ($r = -0.396$, $P < 0.05$) during waking hours.

A good correlation was observed between baroreflex sensitivity and the variability of heart rate during waking hours ($r = 0.695$, $P < 0.001$) and also over 3 h around each measurement of it ($r = 0.500$, $P < 0.001$).

**Discussion**

It is generally agreed that baroreflex sensitivity is reduced in essential hypertensive patients. Our results confirm this. Hossmann et al. [5] reported a circadian rhythm of baroreflex sensitivity which showed a maximum at 12.00 and 03.00 hours in normotensive subjects. In this study we measured baroreflex sensitivity three or four times a day in 30 hypertensive patients: the averages of each measurement showed a variance of $0-5.3$ ms/mmHg during a day in individual patients. But it showed no consistent variation during waking hours. Further study is needed to clarify baroreflex variability in hypertensive patients during sleep. Since heart rate and blood pressure at the time of measurement may influence baroreflex sensitivity, we examined the relationship between baroreflex sensitivity and heart rate or blood pressure. However, no particular relationship was seen between baroreflex sensitivity and heart rate or blood pressure at the time of measurement in each individual.

As in other reports baroreflex sensitivity was inversely correlated with the average systolic and mean blood pressures during waking hours. A negative correlation between baroreflex sensitivity and the variability of systolic blood pressure during waking hours was seen, in agreement with the results of a previous report [7]. Furthermore, we confirmed a negative correlation between baroreflex sensitivity from each measurement at the different times of day and the variability of systolic blood pressure over 3 h around each baroreflex measurement.

From these results it is possible to say that the higher the blood pressure, the greater the variability of blood pressure and the more reduced is baroreflex sensitivity. Baroreflex sensitivity is inversely correlated with the variability of blood pressure not only over the waking hours as previously reported but also over 3 h around each measurement of it. This indicates that baroreflex function influences the short-term variability of blood pressure and its reduction is accompanied by an increase in blood pressure variability in essential hypertensive patients. In our study it was also shown that baroreflex sensitivity was correlated with the variability of heart rate in hypertensive patients during waking hours. Therefore the ability to control heart rate is likely to be reduced in the patients with higher blood pressure because of reduction in baroreflex sensitivity. In other words, blood pressure in the
patients with higher blood pressure would fluctuate more readily with less variability in heart rate.

References


