Hormonal Mechanisms in Blood Pressure Reduction during Hemodialysis in Patients with Chronic Renal Failure

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To elucidate the hormonal mechanisms of blood pressure (BP) reduction during hemodialysis in patients with chronic renal failure (CRF), we performed this study using 7 normotensive (NT) and 17 hypertensive (HT) patients who were strictly matched in age, body weight, body weight gain from the last HD, and duration of HD. Blood pressure, pulse rate, plasma norepinephrine (NE), and plasma dopamine levels were used as indices of sympathetic nerve activity, before, at 50% of hemodialysis (HD) and at 100% of HD (at the end of HD) on the third day after the last HD. As hemodialytic BP reduction was defined as BP decline of more than 10% in pre-HD mean BP, in normotensive patients with CRF, hemodialytic BP reduction was recognized in 0/7 (0%) at 50% of HD and 4/7 (57%) at 100% of HD, and in hypertensive patients it was recognized in 3/17 (18%) at 50% of HD and 4/17 (24%) at 100% of HD. Percentile changes in plasma NE levels increased slightly following hemodialysis in normotensive patients with hemodialytic BP reduction and in hypertensives without BP reduction, while those in normotensives without BP reduction and in hypertensives with BP reduction did not change. However, percentage changes in plasma dopamine (DA) levels decreased significantly at the end of HD (NT; p < 0.05, HT; p < 0.01) following hemodialysis in both normotensive and hypertensive patients with hemodialytic BP reduction, while changes in patients without BP reduction, percentage changes in DA did not change (patients with BP reduction vs. patients without BP reduction). In conclusion, hemodialytic BP reduction may be predisposed by abnormal sympathetic nerve responsiveness. (Hypertens Res 1995; 18 Suppl. 1: S201–S203)

Key Words: hemodialytic blood pressure reduction, plasma norepinephrine level, plasma dopamine level

The mechanism of sudden-onset hypotension occurring in the course of hemodialysis (HD) has not been sufficiently elucidated to date. Numerous reports (1) indicated that autonomic control of the cardiovascular system was abnormal to compensate for hemodynamic changes, hypovolemia, following regular hemodialysis in patients undergoing long-term HD. Moreover, the precise hormonal mechanisms, especially sympathetic nerve activity, in blood pressure (BP) reduction following hemodialysis has not been reported. To assess the sympathetic function in both normotensive and hypertensive CRF patients, we have determined plasma epinephrine (E), norepinephrine (NE) and dopamine (DA) levels during hemodialysis.

Methods

We studied 7 normotensive patients with chronic renal failure (CRF), of mean age 44.6 ± 8.1 (SD) years, mean duration of HD 5.5 ± 2.0 years, mean body weight 48 ± 2 kg and mean body weight gain after the last HD 2410 ± 420 ml, and 17 hypertensive patients, 55.4 ± 3.1 years, 6.8 ± 3.2 years, 52 ± 2 kg and 2970 ± 170 ml. All of the subjects were controlled in regular hemodialysis 3 times per week and in each for 4 h. The average BP reading before HD of normotensive and hypertensive groups was 135 ± 3/72 ± 3 mmHg and 164 ± 3/98 ± 2 mmHg, respectively. This study was approved by the Ethics Committee of Osaka University Medical School and informed consent was obtained.

On day 3 after the last HD following overnight fasting, each subject was kept in the supine position and samples for measurement of electrolytes (Na,K,Cl), epinephrine (E), norepinephrine (NE), and dopamine (DA), before, at 2 h (50% of HD) and at 4 h (100% of HD). The hemodialysis session was performed with FB-150 dialyser, 1.5 m² surface (Nipro, Osaka, Japan). The sodium concentration in the dialysate was 140 mmol/l, the potassium concentration was 2.5 mmol/l, and the bicarbonate concentration was 25 mmol/l. The ultrafiltration flow rate averaged 480 ± 50 ml/h. Blood pressure (BP) and pulse rate were measured with an automated sphygmonanometer (A&D, TM-2713, Tokyo, Japan).

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Japan). Hemodialytic BP reduction was defined as 10% or more decline in predialytic mean BP. Plasma E, NE and DA levels were measured by high performance liquid chromatography with detection using the trihydroxyindole method.

Statistical Analyses

Values are shown as mean ± SD. Changes in variables within each group and differences among groups were examined by two-way analysis of variance (ANOVA). A p value of less than 5% was considered significant.

Results

Hemodialytic BP reduction, defined as 10% or more decline of predialysis mean BP was recognized in 0/7 (0%) of NT, 3/17 (18%) of HT at 50% of HD, and in 4/7 (57%) of NT and 4/17 (24%) of HT at 100% of HD, and that defined as 20/10 mmHg or more decline in systolic/diastolic BP was also recognized as the same frequency, respectively. However, the subjects who showed BP reduction had no symptoms such as vomiting or lowered consciousness in our study.

Plasma E levels in normotensive and hypertensive patients with and without BP reduction did not differ always to each other, and these did not change during hemodialysis in 4 groups (NT without BP reduction: pre-HD, 20±0; 50% of HD, 20±10; 100% of HD, 20±10 pg/ml; NT with BP reduction: 30±10, 30±20, 30±10 pg/ml; HT without BP reduction: 30±10, 20±0, 30±10 pg/ml; HT with BP reduction: 30±10, 10±0, 10±10 pg/ml). Plasma NE levels in normotensive patients with BP reduction were higher than those in normotensive patients without BP reduction (pre-HD: 310±90, 230±10; 50% of HD: 210±50; 140±100; 100% of HD: 290±130, 220±180 pg/ml), while plasma NE levels in hypertensives with BP reduction were less than those in hypertensives without BP reduction (pre-HD: 200±70, 310±70; 50% of HD: 180±60, 220±40; 100% of HD: 190±80, 260±50 pg/ml). Plasma DA levels in both hypertensive and normotensive with BP reduction decreased significantly following hemodialysis (NT: 52±3, 31±4*, 27±3* pg/ml; HT: 51±4, 23±3*, 22±2* pg/ml; *p < 0.05 compared to the value in pre-HD), however, plasma DA levels in the patients without BP reduction did not change (NT: 34±2, 32±3, 32±2 pg/ml; HT: 50±4, 48±3, 49±2 pg/ml). Furthermore, the change in plasma DA levels in patients with BP reduction were significantly less than those in patients without BP reduction (NT: F = 1.58, P = 0.0231; HT: F = 6.79, P = 0.0112).

In Fig. 1, percent changes from the value in pre-HD of plasma NE, and plasma DA, was shown. This figure shows more clearly differences in those hormonal changes than data because the basal (pre-HD) values in those vasoactive peptides were significantly different in each group.

Discussion

Insufficient regulation of BP following dialysis with ultrafiltration has been attributed not only to hemodynamic change, hypovolemia, but also to a lack of hormone activation. In this study, we tried to examine the precise prevalence and vasoactive hormonal mechanism in hemodialytic BP reduction in particular relation to BP status and to sympathetic nerve activity. Our results were the first to document differences in both prevalence and vasoactive peptide hormonal mechanism between normotensive and hypertensive patients. Our results indicate that in patients with chronic renal failure, hemodialytic BP reduction or hypotension was common and increased with higher predialysis BP levels.

Patients with chronic renal failure had plasma NE levels that were not significantly different from those in normotensive subjects, however, plasma NE level is an inappropriate index to sympathetic nervous tone in patients with renal failure (1). Some investigators (2, 3) have also reported that plasma NE clearance was increased in renal failure. However, it is also known that plasma NE, as an
index of sympathetic nerve activity, increases with aging (4) and that plasma NE responses to change is position is increased (5, 6).

In the present study, we measured three fractions of catecholamines: plasma epinephrine (E), nor-epinephrine (NE) and dopamine (DA). Plasma E levels did not differ from each other among the 4 groups and did not change following hemodialysis. Plasma DA in both normotensive and hypertensive patients with BP reduction was suppressed following hemodialysis, while plasma DA in patients without BP reduction did not change. Plasma NE levels in both normotensive and hypertensive patients with BP reduction increased slightly, but in consequence failed to compensate BP reduction.

These results may indicate that the abnormal responsiveness of sympathetic nerve activity and catecholamine clearance to compensate BP reduction caused by hypovolemia exist in patients with chronic renal failure, and that abnormality in sympathetic nerve activity is more severe in hypertensive CRF patients than in normotensive CRF patients, and NE clearance rate is diminished especially in hypertensive, chronic renal failure patients. These results were in good accordance with the reports of Ziegler, et al (1), who reported that all of the biochemical indices of sympathetic nervous function in uremic were abnormal and that plasma NE levels were the results of a slow rate of NE release and decreased NE clearance. On the other hand, the change in plasma NE in normotensive and hypertensive patients without BP reduction was very similar to the changes in plasma DA in those patients. These results were also in good accordance with some investigators (2, 3).

In conclusion, many factors may contribute to the cause of hemodialytic BP reductions, and abnormal sympathetic nerve responsiveness, especially dopamine, may in part, predispose the hemodialytic BP reduction as well as changes in circulating blood volume.

References