Effect of Reduced Alcohol Consumption on Blood Pressure in Untreated Hypertensive Men

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Fifty-four untreated, mildly hypertensive men whose daily alcohol consumption was ≥28 ml ethanol and who drank at least 4 times per week took part in a randomized, controlled crossover trial. The purpose of the trial was to test the effects of alcohol reduction on blood pressure. After a 2-week familiarization period, the participants were assigned to either a reduced alcohol drinking group or a usual drinking group for 3 weeks (experimental period 1). The situation was then reversed for the next 3 weeks (experimental period 2). The participants were requested to limit their daily alcohol consumption to zero or reduce it as much as possible for the reduced alcohol consumption period. The self-reported alcohol consumption was 56.1 ±3.6 (SEM) ml/day during the usual alcohol drinking period and 26.1 ±3.0 ml/day during the period of reduced alcohol consumption. Systolic and diastolic blood pressures in the intervention group were found by analysis of variance to be significantly lower (2.6-4.8 and 2.2-3.0 mm Hg, respectively) than those in the control group during experimental period 2 for systolic blood pressure and experimental period 1 for diastolic blood pressure. Significant (3.6 mm Hg) and nonsignificant (1.9 mm Hg) decreases in systolic and diastolic blood pressure, respectively, were observed. The method of Hills and Armitage was used, reducing ethanol in daily alcohol consumption by 28 ml. The lowering effect of reduced alcohol consumption on blood pressure was independent of changes in salt consumption, which were estimated by 24-hour urine collection and body weight. It was concluded that a reduction in daily alcohol drinking of ethanol from 56 ml to half that amount was feasible and effective in lowering blood pressure for nontreated mildly hypertensive patients who regularly consume alcohol. (Hypertension 1993;21:248-252)

KEY WORDS • alcohol drinking • blood pressure • antihypertensive therapy, nonpharmacological • hypertension, mild

Many cross-sectional epidemiological studies have demonstrated that alcohol consumption is closely related to blood pressure levels and to the prevalence of hypertension. The association seems to be one of cause and effect since it persists even after many confounding factors are taken into consideration. Several controlled trials for hypertensive patients receiving medication and for normotensive subjects found support for the observation that alcohol has a pressor effect and that a reduction in alcohol consumption lowers blood pressure. However, it still remains to be seen whether a reduction in daily alcohol consumption in mildly hypertensive patients who are not taking medication but who have alcohol-drinking habits is an effective means to decrease blood pressure. Accordingly, we carried out a randomized, crossover controlled study to further test the effects on blood pressure of a reduction in daily alcohol consumption in untreated, mildly hypertensive, male office workers.

Methods

Male volunteers, aged 30–59 years, were recruited from their workplace by public health nurses. The volunteers were civil servants with systolic blood pressure ≥140 mm Hg, diastolic blood pressures ≥90 mm Hg, or both, as measured during annual health check-ups. These volunteers also consumed alcohol daily and thus were classified as having drinking habits. Volunteers whose systolic and diastolic blood pressures were between 140 and 179 or 90 and 109 mm Hg, respectively, were eligible for the intervention study, whereas those who were taking antihypertensive medication at the time of the first screening examination were excluded. With regards to drinking habits, only volunteers who consumed more than 28 ml ethanol at least 4 times per week were included in the study. Patients who needed treatment for conditions such as overt diabetes mellitus, hypercholesterolemia, and gout...
were excluded from this study. Only six people refused to participate. After screening, 54 of the 93 volunteers were found to satisfy the criteria for inclusion in the study; accordingly they were asked to give their informed consent. None had ever received antihypertensive medication, and all 54 volunteers completed the study.

Participants were randomly assigned to either group A or B. Group A members were asked to reduce their daily alcohol consumption as much as possible for the first 3 weeks of the experimental period (period 1), and group B was told to maintain its usual alcohol consumption. The situation was reversed for the next 3 weeks (experimental period 2). Blood pressure was measured twice during the day (between 10 AM and 3 PM) using a Random-Zero sphygmomanometer (Hawksley and Sons Ltd., Lancing, UK) with participants in the sitting position. The doctor performing the blood pressure measurements was blinded concerning the treatment phase of the participants. Before blood pressure measurements were taken, each participant was allowed a 5-minute rest period after ensuring that he had refrained from eating, smoking, and strenuous exercise during the previous half hour.

Figure 1 shows the detailed design for the randomized, crossover controlled study. Blood pressure was measured weekly; that is, three times during the 2-week baseline period and once weekly during each 3-week experimental period. Body weight was also measured weekly. Blood chemical analyses were done twice during the baseline period and once during each experimental period. A 24-hour urine collection was done during the baseline period and during each experimental period to measure sodium and potassium excretion. The participants were asked to record their daily alcohol consumption. This record was checked by public health nurses every week during the entire study period of 2 months.

A sample calculation was done based on the results of the previous study in an attempt to detect an 8-mm Hg difference in systolic blood pressure between the two groups. Twenty-seven participants for one group were needed to detect a significant difference that occurred at $\alpha=0.05$ and at $\beta=0.10$. Therefore, the power to detect the difference $(1-\beta)$ was 90% in this study. Significance tests for selected variables, including systolic blood pressure, were done separately on the two groups during periods 1 and 2. Changes in selected variables, including blood pressure changes from the last baseline measurement were compared separately for the two groups by analysis of variance during periods 1 and 2. The treatment effect, combining all participants for the two experimental periods and taking into account all but the urine and blood chemical data for the last 2 weeks, was then calculated using the method of Hills and Armitage. This method was applied to the two-period, crossover controlled study. A two-sided test was done at $\alpha=0.05$.

Results

Table 1 shows a comparison of the baseline data for both groups. Age, height, body mass index, systolic and diastolic blood pressure, and pulse rate were not significantly different between the two groups, although the systolic blood pressure of group B was slightly higher than that of group A. Daily alcohol consumption and its biochemical markers, such as high density lipoprotein (HDL) cholesterol, $\gamma$-glutamyltranspeptidase ($\gamma$-GTP), and uric acid, were not significantly different during the baseline period. Most of the alcohol consumed here was in the form of beer, "sake" (Japanese traditional alcoholic drink), and whiskey. Smoking habits and sodium and potassium excretion in 24-hour urine collection were not significantly different.

The request to reduce alcohol for the first 3 weeks (experimental period 1) of the study was well accepted by participants in group A. Similarly, the request to maintain usual alcohol consumption for the same period was accepted by group B participants (Figure 2). The situation was then reversed for the next 3-week period.

Groups A and B were compared with respect to changes from baseline in systolic blood pressure. The systolic blood pressure of the subjects in group A, who reduced alcohol consumption to half, showed a large decline compared with that of group B during period 1 (Figure 3). In period 2, the systolic blood pressure of subjects in group A, who returned to their usual drinking habits, increased somewhat, whereas the systolic blood pressure of those in group B, who reduced alcohol consumption, declined further from the level of the control period when usual alcohol drinking resumed. The 2.6–4.8 mm Hg difference in systolic blood pressure between the two groups in period 2 was significant by analysis of variance (Figure 3). Similarly, the 2.2–3.0 mm Hg difference in diastolic blood pressure between the two groups during period 1 was significant (Figure 4).

Further analysis was done using the method of Hills and Armitage to detect a treatment effect. Table 2 shows the changes in alcohol consumption and its biochemical markers after combining both groups. Alcohol consumption during the treatment period was found to be half that of the amount consumed in either the baseline or control period. Biochemical markers of alcohol consumption, such as $\gamma$-GTP and HDL cholesterol...
terol, changed simultaneously with reported alcohol consumption (Table 2). These changes were significant.

The treatment effect of alcohol consumption reduction on blood pressure was also assessed using the Hills and Armitage method (Table 2). The decrease of 3.6 mm Hg in systolic blood pressure was significant, but the drop of 1.9 mm Hg in diastolic blood pressure was not. Body weight, pulse rate, and sodium and potassium excretion did not change significantly during either of the experimental periods. The treatment-period interaction was also tested using the Hills and Armitage method; however, it was not significant even for blood pressure and alcohol consumption.

**Discussion**

A reduction in daily alcohol consumption to half was observed to significantly lower the blood pressure of mildly hypertensive men with the aid of antihypertensive medication. The present study was done under normal working conditions. Most participants were compliant when asked to reduce or discontinue their daily alcohol consumption as much as possible during the former or latter half of the 6-week experimental period. Thus, the results suggest that it is feasible to reduce daily alcohol consumption to half and that a reduction in alcohol consumption in daily life may lower blood pressure significantly.

The differences between the two groups in systolic blood pressure during period 2 and in diastolic blood pressure during period 1 were 2.6–4.8 and 2.2–3.0 mm Hg, respectively. The decrease in blood pressure

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**TABLE 1.** A Comparison Between the Baseline Data of Group A and Group B in a Randomized, Controlled Crossover Trial for Mildly Hypertensive Men Not Taking Any Medication

<table>
<thead>
<tr>
<th>Variables</th>
<th>Group A (n=27)</th>
<th>Group B (n=27)</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age (years)</td>
<td>43.3 (7.8)</td>
<td>45.0 (7.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Height (cm)</td>
<td>165.7 (5.6)</td>
<td>167.6 (6.5)</td>
<td>NS</td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>67.7 (7.6)</td>
<td>67.6 (6.6)</td>
<td>NS</td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>24.6 (1.9)</td>
<td>24.1 (2.1)</td>
<td>NS</td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>141.7 (13.7)</td>
<td>146.1 (12.3)</td>
<td>NS</td>
</tr>
<tr>
<td>DBP (mm Hg)</td>
<td>95.6 (9.7)</td>
<td>97.2 (7.8)</td>
<td>NS</td>
</tr>
<tr>
<td>Pulse (bpm)</td>
<td>74.2 (9.2)</td>
<td>76.6 (9.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Alcohol (ethanol, ml/day)</td>
<td>61.6 (30.5)</td>
<td>51.7 (19.6)</td>
<td>NS</td>
</tr>
<tr>
<td>Cigarette smoking (No./day)</td>
<td>13.0 (17.6)</td>
<td>16.3 (18.2)</td>
<td>NS</td>
</tr>
<tr>
<td>Smoking rate (%)</td>
<td>44.4</td>
<td>55.6</td>
<td>NS</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>1.32 (0.38)</td>
<td>1.22 (0.21)</td>
<td>NS</td>
</tr>
<tr>
<td>y-GTP (units/L)</td>
<td>122.5 (94.8)</td>
<td>111.1 (97.1)</td>
<td>NS</td>
</tr>
<tr>
<td>Uric acid (mmol/L)</td>
<td>387.8 (74.9)</td>
<td>365.2 (83.8)</td>
<td>NS</td>
</tr>
<tr>
<td>Sodium (mmol/day)</td>
<td>212.0 (38.1)</td>
<td>201.8 (56.4)</td>
<td>NS</td>
</tr>
<tr>
<td>Potassium (mmol/day)</td>
<td>46.6 (11.3)</td>
<td>44.5 (13.2)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Values are mean (±SD). BMI, body mass index (weight/height² [kg/m²]); SBP, systolic blood pressure; DBP, diastolic blood pressure; bpm, beats per minute; HDL, high density lipoprotein; y-GTP, y-glutamyltranspeptidase. With the exception of the smoking rate for which a chi² test was done, t tests were used to compare between-group variables.

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**FIGURE 2.** Bar graph shows average daily alcohol consumption (ethanol in milliliters per day per capita) for groups A and B during the familiarization baseline period and during experimental periods 1 and 2 in a randomized, controlled crossover trial. Daily alcohol consumption was calculated for the 2-week familiarization period and for each week during experimental periods 1 and 2.

**FIGURE 3.** Line graph shows changes in systolic blood pressure (SBP) level with one standard error from the baseline on the last day of the familiarization period for groups A and B in a randomized, controlled crossover trial. Data were collected from 54 mildly hypertensive men who regularly drank alcohol and were not taking any medication. In period 2, SBP was significantly lower (2.6–4.8 mm Hg) in group B, the reduced alcohol consumption group, than in group A, the usual drinking group. Significance test was done by analysis of variance.
resulting from a reduction in daily alcohol consumption by 30.0 ml was on average 3.6 mm Hg for systolic blood pressure and 1.9 mm Hg for diastolic blood pressure. This calculation was done using the treatment effect of Hills and Armitage.24 Based on this observation, it may be reasoned that a fall in systolic blood pressure of 5 mm Hg will result from the daily elimination of three drinks (42 ml ethanol). The volunteers who participated in this study were mildly hypertensive subjects who were not taking any medication. One large scale clinical trial in mild hypertension reported that participants assigned to a β-blocker treatment group lowered their systolic blood pressure, obtained by adjusting the daily alcohol consumption, is equivalent to half the effect of drug treatment. Puddey et al19 also observed approximately the same magnitude of blood pressure decline, 5.0 and 3.0 mm Hg for systolic and diastolic blood pressure, respectively, after daily ethanol consumption was reduced from 65 to 9 ml in mildly hypertensive subjects who were taking medication. In their study, however, the effect on blood pressure was observed within 2 weeks after reducing alcohol consumption. Other randomized controlled studies have also showed similar results.17-21,23

In the present study, the decline in diastolic blood pressure was not as clearly evident as the decline in systolic blood pressure. This may have been due to the absence of an increase in the effect on diastolic blood pressure during the usual drinking period and after the reduced alcohol drinking period; that is, the diastolic blood pressure in group A did not increase despite a return to usual drinking habits. The reason is not clear. The same observation was seen in a trial of normotensive men.18

Although many epidemiological and clinical studies support the cause–effect relation, the pressor mechanism of alcohol remains unknown.1 In Japan, salt has been suspected as a confounding factor in this relation because when Japanese people drink alcoholic beverages such as "sake" or beer they customarily eat salty foods.26 According to the 24-hour urine collection of this randomized controlled study, however, salt consumption was not reduced during the period of low alcohol consumption. Furthermore, this study showed that potassium excretions in 24-hour urine collection were quite stable. Therefore, it may be concluded that the depressive effect on blood pressure by reducing alcohol consumption is independent of changes in sodium and potassium intake.

The INTERSALT study is a well-standardized, large-scale population survey on the relation between blood pressure and minerals in urine. This study has involved the examination of over 10,000 people in 52 population groups across 32 countries.27 In support of our findings, the INTERSALT study also showed that high alcohol consumption (150 ml/wk) was related to hypertension, independent of sodium and potassium excretion in 24-hour urine collection or body mass index (weight/
height\(^2\), kg/m\(^2\)).\(^{27}\) Since body weight did not change during the experimental period, we concluded that the fall in blood pressure was not related to weight change.

Some epidemiological studies have revealed that there is a relation between pulse rate and blood pressure.\(^{28}\) However, except for the fact that in the period of reduced alcohol consumption, the pulse rate was 2 beats per minute lower than in the period of usual alcohol consumption, we did not find any dramatic changes in pulse rate. Thus, because of a lack of evidence, the exact nature of the pressor mechanism associated with alcohol drinking and mediated by sympathetic nerve activity still remains unclear in the present study.

One limitation of the present study is the shortness of the intervention period. The long-term effect of reduced daily alcohol consumption on blood pressure could not be assessed. However, from the results of many cross-sectional and prospective studies\(^{11-15}\) and a long-term intervention trial,\(^{22}\) it is reasonable to expect that mildly hypertensive patients can maintain the treatment effect of reduced daily alcohol intake on lowering blood pressure if reduction in daily alcohol consumption is continued. Furthermore, some intervention studies showed that advice to change to a beer with low alcohol content\(^{18,19}\) or to reduce alcohol consumption\(^{21-23}\) would also be feasible and effective in lowering blood pressure.

In conclusion, moderation of daily alcohol consumption as a nonpharmacological means of treatment under normal working conditions seems to be a feasible and effective method for lowering blood pressure in untreated, mildly hypertensive patients who regularly drink alcohol. Because the effects of alcohol reduction on blood pressure levels may appear within 2 to 3 weeks,\(^{16-21}\) patients who consume more than two drinks per day should be advised to reduce their alcohol intake.

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