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.

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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.1-13 The association seems to be one of cause and effect since it persists even after many confounding factors are taken into consideration.1,5,8,11-13 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.16-23 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 also excluded. Patient characteristics are shown in Table 1.
Blood chemical analyses were done twice during
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 sys-
tolic 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 ac-
count 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 signif-
icantly different between the two groups, although the
dsystolic 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 alco-
holic 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 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. Al-
cohol 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 choles-

**Figure 1.** Schematic shows design for a randomized, con-
trolled crossover study testing the effects of a reduction in daily
alcohol consumption on blood pressure (BP) in 54 mildly
hypertensive men who were not taking any medication and
who regularly drank alcohol. BP and body weight were
measured every week. Blood was drawn at the initial exami-
nation, during the last week of the familiarization period, and
during the last week of each experimental period. Daily
alcohol consumption was recorded during the study period.
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>γ-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; γ-GTP, γ-glutamyltranspeptidase. With the exception of the smoking rate for which a χ² test was done, t tests were used to compare between-group variables.

Discussion

A reduction in daily alcohol consumption to half was observed to significantly lower the blood pressure of mildly hypertensive men without 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 by guest on November 1, 2017 http://hyper.ahajournals.org/ Downloaded from
pressure (DBP) level with one standard error from 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 drank alcohol regularly and were not taking any medication. In period 1, DBP was significantly lower (2.2–3.0 mm Hg) in group A, the regular drinking group. 25 Therefore, the 5-mm Hg fall in systolic blood pressure, obtained by adjusting the daily alcohol consumption, is equivalent to half the effect of drug treatment. Reduced alcohol consumption group, than in group B, 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 for mild hypertension reported that participants assigned to a β-blocker treatment group lowered their systolic blood pressure by 10 mm Hg more than the control group. 25 Therefore, the 5-mm Hg fall in systolic blood pressure, obtained by adjusting the daily alcohol consumption, is equivalent to half the effect of drug treatment. Puddey et al 19 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, especially after the examination of over 10,000 people in 52 population groups across 32 countries. 27

Table 2. Effect on Blood Pressure and Other Selected Variables for the Combined Groups (n=54) in a Randomized, Controlled Crossover Trial Involving Treatment by a Reduction in Daily Alcohol Consumption

<table>
<thead>
<tr>
<th>Variables</th>
<th>Baseline</th>
<th>Reduced alcohol</th>
<th>Usual alcohol</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol (ethanol, mL/day)</td>
<td>56.7 (3.5)</td>
<td>26.1 (3.0)</td>
<td>56.1 (3.6)</td>
<td>&lt;0.001</td>
</tr>
<tr>
<td>HDL cholesterol (mmol/L)</td>
<td>1.27 (0.04)</td>
<td>1.13 (0.04)</td>
<td>1.21 (0.04)</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>γ-GTP (units/L)</td>
<td>116.8 (13.0)</td>
<td>87.9 (9.2)</td>
<td>101.0 (11.0)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>SBP (mm Hg)</td>
<td>143.9 (1.8)</td>
<td>136.5 (1.5)</td>
<td>140.1 (1.3)</td>
<td>&lt;0.05</td>
</tr>
<tr>
<td>DBP (mm Hg)</td>
<td>96.4 (1.2)</td>
<td>91.0 (1.0)</td>
<td>92.9 (0.9)</td>
<td>NS</td>
</tr>
<tr>
<td>Body weight (kg)</td>
<td>67.7 (1.0)</td>
<td>67.6 (0.9)</td>
<td>67.7 (0.9)</td>
<td>NS</td>
</tr>
<tr>
<td>Pulse rate (bpm)</td>
<td>75.4 (1.3)</td>
<td>73.9 (1.2)</td>
<td>75.7 (1.1)</td>
<td>NS</td>
</tr>
<tr>
<td>Sodium (mmol/day)</td>
<td>206.9 (8.6)</td>
<td>227.4 (10.3)</td>
<td>220.6 (10.3)</td>
<td>NS</td>
</tr>
<tr>
<td>Potassium (mmol/day)</td>
<td>45.5 (1.7)</td>
<td>47.1 (2.0)</td>
<td>47.1 (1.8)</td>
<td>NS</td>
</tr>
</tbody>
</table>

Values are mean (±SD). HDL, high density lipoprotein; γ-GTP, γ-glutamyltranspeptidase; SBP, systolic blood pressure; DBP, diastolic blood pressure; bpm, beats per minute. The treatment effect was tested using the method of Hills and Armitage. 24 Testing was done using data from the last 2 weeks in periods 1 and 2, but using the single data at the end of each experimental period for HDL cholesterol, γ-GTP, sodium, and potassium.
height², kg/m²).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 studies¹¹-¹⁵ 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 content¹⁵,¹⁹ or to reduce alcohol consumption²¹-²² 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,¹⁶-²¹,²³ patients who consume more than two drinks per day should be advised to reduce their alcohol intake.

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