Alcohol consumption and frontal lobe shrinkage: study of 1432 non-alcoholic subjects

M Kubota, S Nakazaki, S Hirai, N Saeki, A Yamaura, T Kusaka

Abstract

Objectives—To evaluate the influences of chronic alcohol consumption on brain volume among social drinkers, as it is well known that alcohol misusers have a high risk of brain shrinkage.

Methods—Frontal lobe volumes on MRI were compared with the current alcohol habits of consecutive 1432 non-alcoholic subjects.

Results—After adjusting for other variables, age was found to be the most powerful promoting factor for the shrinkage with an odds ratio of 2.8 (95% confidence interval 1.23–3.06) for each 10 years of age. Regarding alcohol habit, 667 of the subjects were abstainers, and 157, 362, and 246 of the subjects were light (average 88.2 g ethanol/week), moderate (181.2 g/week), and heavy (418.1 g/week) drinkers, respectively. Moderate alcohol consumption did not increase the incidence of frontal lobe shrinkage (odds ratio 0.98; 95% CI 0.73–1.33), whereas heavy drinkers were at a higher risk compared with abstainers (1.80; 1.32–2.46). The contributory rate of alcohol consumption for frontal lobe shrinkage was 11.3%.

Conclusion—The brain tends to shrink physiologically with age. Heavy alcohol consumption seems to exaggerate this shrinkage in social drinkers. Moderate alcohol consumption does not seem to affect brain volume.

Keywords: alcohol; social drinker; brain atrophy

Many studies on the effects of alcohol on brain morphometry have disclosed that a large amount of alcohol consumption can induce brain shrinkage. To evaluate the effects of alcohol on brain volume among social drinkers, we compared the findings of frontal lobe shrinkage on MRI with current alcoholic habits of consecutive 1432 volunteers.

Subjects and methods

We divided the subjects into four categories based on their current alcohol habit: abstainers, light drinkers (drinkers who consumed alcoholic beverages less than three times a week), moderate drinkers (drinkers who consumed alcohol more than four times a week, but who consumed less than 14 units of Japanese alcohol consumption a week (1 unit=180 ml of Sake (ethanol content 14%), 14 units= about 350 g of ethanol a week), and heavy drinkers (drinkers who consumed 14 units or more a week). All participants underwent MRI with a 1.5 T MR unit (Signa Horizon, GE). Frontal lobe volume was evaluated with 3 mm thick axial T2 weighted images. Widening of the CSF space of the frontal surface was considered to indicate shrinkage of the frontal lobe. The extent of the shrinkage was classified into four categories based on the width of the CSF space: no shrinkage (≤2 mm), mild shrinkage (3–5 mm), moderate shrinkage (6–8 mm), and severe shrinkage (≥9 mm).

No subjects had medical histories of head injury, stroke, or other neurological disorders. All statistical analyses were performed using the commercially available SPSS statistical package (SPSS Japan Inc). p Values<0.05 were regarded as significant.

Results

A total of 1432 subjects (1061 men and 371 women) were recruited for analysis. Of these, 236, 536, 433, and 277 were in their 30s, 40s, 50s, and 60s, respectively (mean 49.1 (SD 10.1) years old). Concerning their alcohol habits, 667 of the subjects (46.5%) were abstainers and 157 (11.0%), 362 (25.3%), and 246 (17.2%) were light, moderate, and heavy drinkers, respectively. They light, moderate, and heavy drinkers consumed 88.2 g, 181.2 g, and 418.1 g of ethanol a week on average. Older subjects had moderated their alcohol consumption significantly compared with the younger subjects (p<0.01). In the 30s age group, 125 of the subjects (53.0%) were regular drinkers, compared with 246 (45.9%) in the 40s age group, 158 (36.5%) in the 50s age group, and 79 (34.8%) in the 60s age group.

The frontal lobe shrunk with age (p<0.01). In the 30s age group, only 18 (7.6%) had shrunken frontal lobes. In the 40s age group,
Alcohol consumption and frontal lobe shrinkage

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CR=Contributory rate.

Hypercholesterolaemia 1.47 1.23–1.76 0.03 4.0
Diabetes mellitus 1.68 1.35–2.10 0.02 4.6
Hypertension 1.05 0.96–1.16 0.59 0
Cigarette smoking 1.11 1.01–1.23 0.29 0
Alcohol consumption 2.27 1.53–2.69 <0.01 11.3
Age 2.82 1.23–3.06 <0.01 31.0

However, most of these studies involved

Many investigators have reported that heavy
drinkers were at twice the
risk for atrophy in the 30s to 50s age groups.

Compared with abstainers to moderate drink-
ers. Heavy alcohol drinkers were at twice the
consumption was the second most important
independent determinant, with a CR of 11.3%.

The odds ratio (OR) for moderate drinkers
was 0.98 (95% confidence interval (95% CI)
0.73–1.33, p=0.92), whereas that for heavy
drinkers was 1.80 (95% CI 1.32–2.46,
p<0.01). Figure 1 shows the incidence in each
age group of frontal shrinkage. In the 30s to
50s age groups, heavy consumption of alcohol
doubled the risk for frontal lobe shrinkage
(ORs 2.1 in the 30s, 1.9 in the 40s, and 2.2 in
the 50s age groups, respectively). In the 60s age
group, heavy drinkers showed a minimal and
non-significant increase in risk (OR 1.3,
p=0.44).

As shown in table 1, aging was the most
powerful determinant of frontal lobe shrinkage
after adjusting for other variables. The inci-
dence was increased 2.8 times for each 10 years
(95% CI 1.23–3.06, p<0.01). The contributi-
ory rate (CR) for aging was 31.0%. Alcohol
consumption was the second most important
independent determinant, with a CR of 11.3%.
Compared with abstainers to moderate drink-
ers, heavy alcohol drinkers were at twice the
risk for atrophy in the 30s to 50s age groups
(OR 2.27, p<0.01).

Discussion
Many investigators have reported that heavy
alcohol consumption accelerates brain shrink-
age. However, most of these studies involved
alcohol dependent patients. It had not been
definitively established whether social drinkers
also have reduced brain volumes. Therefore,
we evaluated the influences of chronic alcohol
consumption on brain volumes in a consecu-
tive 1432 non-alcoholic subjects.

We measured the frontal CSF space as the
indicator for alcoholic brain shrinkage, because
alcoholic brain damage is particularly known to
affect the frontal lobes.2,3,5 After adjusting for
other variables, aging remained the most pow-
erful determinant of such brain shrinkage,
which indicates that brain shrinkage is a phys-
ological phenomenon, advancing with age.

Light to moderate alcohol consumption
seemed not to affect brain volume, whereas
heavy alcohol consumption might exaggerate
brain shrinkage in the non-alcoholic middle
aged population. The contributory rate of
alcohol consumption was 11.3%, and about a
tenth of the atrophy might thus be attributable
to the effect of alcohol. We failed to show this
influence in the elderly group, possibly because
dominating a ceiling effect. However, another possibility
is that some of the former heavy alcohol
consumers were classified into light to moder-
ate drinkers, because older subjects tended to
moderate their alcohol consumption. Further
study is needed to evaluate the effects in an
elderly population.

Alcoholic brain atrophy is known to be asso-
ciated with reduced cerebral blood flow4,5,6 and
glucose metabolism,7 impaired evoked poten-
tials,7 and cognitive function and antisocial
behaviour.7,8 As shown in this study, it is likely
that about a tenth of the brain atrophy found in
the normal population might be caused by
excessive alcohol consumption. Chronic heavy
alcohol consumption of more than 350 g etha-
nol a week should consequently be avoided. In
our study, the moderate consumption of
alcohol (average 181.2 g ethanol a week) did
not affect frontal lobe volume. Fortunately,
alcoholic brain damage is known to be, at least
in part, reversible.8,9 After only a few months
of abstinence, brain volume, cerebral blood
flow, and neuropsychological impairment
showed a gradual recovery.10,11

Table 1 Multivariate analysis by logistic regression

<table>
<thead>
<tr>
<th>OR</th>
<th>95%CI</th>
<th>p Value</th>
<th>CR (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age</td>
<td>2.82</td>
<td>1.23–3.06</td>
<td>&lt;0.01</td>
</tr>
<tr>
<td>Alcohol consumption</td>
<td>2.27</td>
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</tr>
</tbody>
</table>

CR=Contributory rate.

84 (15.6%) of the subjects showed frontal lobe
shrinkage, as did 164 (37.9 %) in the 50s age
group. More than half of the subjects (138,
60.8 %) showed frontal lobe shrinkage in the
60s age group, and 46 subjects (20.3 %) had
moderately to severely shrunken frontal lobes.

Light to moderate alcohol consumption did
not increase the rate of frontal lobe shrinkage,
whereas heavy drinkers had significantly
shrunken frontal lobes compared with abstainers.
The odds ratio (OR) for moderate drinkers
was 0.98 (95% confidence interval (95% CI)
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We thank Mr S Niikura, Mr H Takeshi, and Miss H Sano for their help in preparing this study.


