The Basis for Differences in Ethanol-Induced Myocardial Depression in Normal Subjects

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SUMMARY

The acute effects of ethanol (ETOH) on cardiac function in 32 normal subjects has been studied utilizing systolic time intervals. Seven (group I), 13 (group II), and 12 subjects (group III), reported an average daily consumption of less than 1 oz, 1-2 oz, and more than 2 oz of ETOH, respectively. Progressively higher control values from group I to group III in PEP, PEPI, ICT and PEP/LVET were observed (PEPI-I vs. PEPI-III: P < 0.05; PEP/LVET-I vs PEP/LVET-II and PEP/LVET-III: P < 0.05). There was progressively less change in these variables following acute ETOH (P < 0.02-0.05 in group I; P = NS in group III; group II intermediate). This indicates some degree of chronic myocardial impairment in group II and especially in group III, which tends to be proportionate to the degree of chronic ETOH exposure. These data are not necessarily disparate with previous reports of little or even a salutary hemodynamic effect of ETOH in normal subjects. Thus, the relative stability of LVET post ETOH, coupled with the observed increase in heart rate, is consistent with previous reports of ETOH-induced rate-dependent increments in cardiac output with unchanging stroke volumes, in spite of the presence of acute myocardial depression.

The observations reported herein demonstrate the probable incremental influence of ETOH consumption in a chain of events which may culminate in alcoholic cardiomyopathy.

Additional Indexing Words:
Ethanol  Myocardial depression  Normal subjects

MEASURABLE CARDIAC IMPAIRMENT involving both pump and muscle function, as well as metabolic changes, have been frequently reported to result from either acute or chronic exposure to ethanol (ETOH).1-8 Until recently, cardiac dysfunction resulting from this agent has been observed only in chronic alcoholics1, 2, 6-8 and patients with pre-existing cardiac disease.3-5 On the other hand, in healthy subjects ETOH has been reputed to generate either no significant depressive effect on cardiac performance,8 or even a salutary effect.9, 10 These latter studies have primarily dealt with the hemodynamic effects of acute ETOH exposure as opposed to those reflecting intrinsic myocardial function. In the only exception, Riff reported no impairment in left ventricular contractility.11

More recently, in our laboratory and elsewhere, using noninvasive techniques, acute consumption of ETOH has been demonstrated to produce depressed cardiac function in normal subjects.12-14 The basis for these latest findings, in the context of previous human data, may reflect the discordant effects of an acute intervention on the pump and muscle function of the heart.15 These latter studies, using systolic time intervals (STI), are sensitive to fluxes in both hemodynamics16-19 and the contractile state of the left ventricular myocardium.20

This report deals with another possible explanation for the apparent disparate effects of acute ETOH on cardiac performance. Specifically, the relationship of previous (habitual) ETOH exposure to its acute cardiac effects in normal subjects was studied.

Method

Thirty-two normal subjects, having given their informed consent, were included in this study when judged by historical inquiry to be normal from a cardiovascular standpoint. They were selected from a group of 62 candidates only if they had had a physical examination and chest X-ray within 12 months immediately prior to the study. These latter studies were uniformly performed by the health clinics of the two institutions from which these people were obtained (employees from the hospital and a local technical center). There were 20 males and 12 females. Ages ranged from 19-51 years (mean 26.8) and weights from 115-230 pounds. A dose of 50% ETOH, given as 100 proof vodka, was determined for each patient on the basis of his previous exposure. Subjects were classified as light, average, or heavy drinkers based on an estimated consumption of less than 1 oz/day (group I), 1-2 oz/day (group II), and more than 2 oz/day (group III) respectively. Mean age and weight were
27 years and 177 pounds for group I (six males, one female), 28 years and 135 pounds for group II (seven males, six females), and 26 years and 163 pounds for group III (seven males, five females). To offset a potential tolerance effect, a dose of 1.0, 1.25, and 1.5 ml/lb body weight ETOH was administered to group I, group II, and group III subjects, respectively, in four equally divided doses over a period of 80 minutes, in orange or tomato juice, after a 30 minute period of recumbent rest. Ethanol blood levels were estimated by enzymatic determination immediately prior to the measurement of systolic time intervals.13 The latter were measured 60–70 min after the last dose of ETOH, according to the technique of Weissler et al., as previously reported from this laboratory.14,15 From a simultaneously recorded electrocardiogram, phonocardiogram, and external carotid pulse trace, the following STI were calculated: total electromechanical systolic interval (QS,), left ventricular ejection time (LVET), pre-ejection period (PEP), isovolumic contraction time (ICT), and ratio PEP/LVET. With the exception of the latter, all STI were corrected for heart rate using published regression equations.16 Rate-corrected indices were indicated by the letter "I" (e.g., PEPi, LVETi, and QS2i). All data were analyzed using the paired t-test for small samples and Student's t-test.

Results

Table 1 illustrates the effects of ethanol consumption on systolic time intervals.

Significant changes in group I (P < 0.05) were noted in PEP, PEPi, LVET, QS2I, ICT and PEP/LVET (table 1). In Group III no significant change was measured in any systolic time interval.

The responses of group II fell somewhere between these findings: PEPi and PEP/LVET increased (P < 0.05) as LVET decreased (P < 0.01), but there was no significant change in PEP, ICT, or QS2I. Moreover, the degree of change in those STI significantly affected by ETOH was relatively less than similar changes in group I (fig. 1).

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All values except PEP/LVET are expressed in milliseconds.

Abbreviations: C = control; E = ETOH; NS = not significant; SD = standard deviation of ΔC - E; QS2 = total electromechanical systole; I = index; LVET = left ventricular ejection time; PEP = pre-ejection period; ICT = isovolumic contraction time; HR = heart rate.

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The largest intergroup difference was in ICT and PEP/LVET relative to control values (fig. 1). Somewhat lower but still important differences between groups in response of PEP and PEPI were observed. The increases noted in PEP, PEPI, ICT, and PEP/LVET in group III were small. These data are given in table 1 but figures 2–4 emphasize the progressively smaller effect of acute ETOH ingestion on these indices in groups II and III. Little change was seen in the group III absolute and rate-corrected ejection time. However, LVETI was also less strikingly altered, as compared to other STI, in groups I and II. The least striking effects were noted in the absolute and rate-corrected electromechanical systole interval. The similarity between control data in group III to ETOH data in group I is striking (table 1; fig. 2–4). Intermediate comparisons were observed in group II. Significant intergroup differences in control data were noted for PEPI (group I vs group III; \( P < 0.05 \)) and PEP/LVET (group I vs group II and group I vs group III; \( P < 0.05 \)).

Table 2 demonstrates a significant difference in blood alcohol levels only in group III as compared to group II.

**Discussion**

That ETOH adversely affects the human myocardium has been suspected for over a hundred years. Many investigators have assumed, on the basis of clinical experience, that ETOH may be so intimately associated with cardiac disease that excessive alcohol ingestion actually produces a cardiomyopathy. This assumption may have been founded on the knowledge that the mammalian heart lacks alcohol dehydrogenase which catalyzes the first oxidation of ETOH, a known cellular toxin, even in those tissue beds in which this enzyme abounds. Both Spodick’s and Witham’s groups have described a subclinical form of cardiac malfunction in alcoholics, in the absence of clinical, electrocardiographic or roentgenographic evidence of heart disease. Thus, it is not surprising that the acute depressive effects of ETOH are detectable, as reported herein.

If all three of our groups had been given an equal dose of ETOH on a volume/weight basis, the group differences in STI would, at least on a statistical basis, be no less significant. The fact that the resistance to STI changes especially in group III was minimally influenced by higher blood levels of ETOH is even more impressive. A tolerance effect which was considered in our prestudy hypotheses can be excluded by noting the similarity of the post ETOH variables in group I to the equivalent control values in group III (table 1; fig. 2–4). Progressive increases from group I to group III in control PEP, PEPI, ICT, and PEP/LVET, all of which are influenced by changes in myocardial contractility, suggest a level of myocardial impairment roughly proportionate to the degree of chronic ETOH...
ETOH AND MYOCARDIAL DEPRESSION

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22. Parker BM: The effects of ethyl alcohol on the heart. JAMA 228: 741, 1974
The basis for differences in ethanol-induced myocardial depression in normal subjects.
G C Timmis, R C Ramos, S Gordon and V Gangadharan

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