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ANALYSIS OF DEPENDENCE BETWEEN THE CHARACTER OF ALCOHOL INTAKE BY ADULTS AND RHEOLOGIC PROPERTIES OF THE WHOLE BLOOD

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Abstract. Object of the study: adults aged from 17 to 94. Selection criteria are as follows: for inclusion – minimum age of 17 years, for exclusion – treatment in hospital or polyclinic. Remoteness of the last intake and frequency of alcohol intake were studied according to questionnaire data. Blood, plasma, serum viscosities were investigated by the rotary viscometer. Calculation of aggregation indices and erythrocyte deformation has been carried out. It has been demonstrated that change in plasma and serum viscosities makes the basis of alcohol effect on hemorheology of the whole blood. Alcohol intake the day before the examination decreases serum and plasma viscosities. Regular weekly alcohol intake by men and women of all the age periods leads to increase of serum and plasma viscosities.

Key words: alcohol, blood rheology, experiment

Introduction

Alcohol is a psychotropic preparation and is used for removal of physical and psychological discomfort. Alcohol intake causes many clinical effects, including change in systemic and local hemodynamics. The aim of the present study was to investigate correlation between the character of alcohol intake by adults and change in the whole blood rheology in modeling of biomechanical conditions of the real vascular bed. The following tasks were distinguished: 1) to determine indices of the whole blood rheologic properties and to evaluate the character of alcohol intake in a great selection of adults of different age periods; 2) to estimate correlation between the character of alcohol intake and rheologic properties of the whole blood. The number of days after the last alcohol intake, frequency of alcohol intake (weekly, monthly, rarely), indices of hemorheology (viscosity and pseudoplastic behavior of whole blood, plasma and serum viscosities) were studied.

Materials and methods

Study design. We used a single-moment study. All the methods were applied in the morning between 9 and 10 o'clock. No check was made on intake of food or drink, on smoking or on physical activity before the examination.

Selection criteria. For inclusion: minimum age of 17 years. For exclusion: treatment in polyclinic or hospital.

Investigation volume: 984 subjects (489 men and 495 women). Age distribution in men: from 17 to 19 (83 subjects), from 20 to 29 (84 subjects), from 30 to 39 (79 subjects), from 40 to 49 (78 subjects), from 50 to 59 (75 subjects), older than 60 (90 subjects). Age

distribution in women: from 17 to 19 (71 subjects), from 20 to 29 (66 subjects), from 30 to 39 (70 subjects), from 40 to 49 (81 subjects), from 50 to 59 (82 subjects), older than 60 (125 subjects). Remoteness of the last alcohol intake was determined by the question: «How many days ago did you drink alcohol?» - and was estimated by the number of days, indicated by the respondent. Frequency of alcohol intake was studied according to the variant of the answer to the question: «Indicate regularity of alcohol intake: weekly, monthly, rarely». Weekly alcohol intake was estimated as 3 numbers, monthly as 2 numbers, rarely as 1 number. The volume and the quality of the taken alcohol were not taken into consideration. Reliability, validity and sensitivity of the questions were determined in 118 respondents not included in the investigation. Cronbach coefficient was 0.98 [1].

Measurement method. Treatment of the venous blood: the samples were taken from the antecubital vein. For stabilization the blood was mixed with an anticoagulant in the ratio 9:1. The measurements were carried out within four hours of the venipuncture. Before testing the blood was stored in a refrigerator at the temperature of +4° to +10° C.

Anticoagulant: sodium citrate.

Instrument used: the rotary viscometer AKR-2 (Russia). The whole blood viscosity was measured by the viscometer AKR-2 at shear rates 200, 100 and 20 sec^{-1}. Viscosities of the blood and its components were measured at the temperature of analyzer thermostating +37° C. AKR-2 investigation was carried out with one cylinder. Erythrocytes deformation index represented quotient from division of blood viscosity at shear rates 100 and 200 sec^{-1}, demonstrating their ability to deformation [2]. Erythrocytes aggregation index represented quotient from division of blood viscosity at shear rates 20 sec^{-1} and 100 sec^{-1} that characterized expressivity of erythrocytes aggregation process [2]. Plasma viscosity was determined by AKR-2 at shear rate 100 sec^{-1} [2]. Serum viscosity was measured by AKR-2 at shear rate 100 sec^{-1} [2].

Methods of statistical analysis. Character of variables studied: independent - the number of days after the last alcohol intake, estimation of alcohol intake frequency; dependent - indices of hemorheology (whole blood viscosity at shear rate 100 sec^{-1}; plasma viscosity, serum viscosity, erythrocytes aggregation index, erythrocytes deformation index). In accordance with the aims of investigation the zero hypothesis, concerning the absence of linear dependence between the studied variables (remoteness of alcohol intake and indices of hemorheology, frequency of alcohol intake and indices of hemorheology) was put foreward. Availability evaluation of the zero hypothesis was conducted by Spirmen rank correlation [3].

Statistics. Values were considered significant when $p < 0.05$. The statistical analysis was carried out using the programs «Biostat» (Version 4.03, «Primer of Biostatistics, 1998», Practice, Moscow) and «Statistica'99» (Version 5.5 A, «Statsoft, Inc.», Moscow, 1999).

Results and discussion

72 men indicated recent alcohol intake (1-3 days before the examination). Not more than a week ago (4-7 days before) alcohol was taken by 63 men. 81 men indicated alcohol intake from 8 to 14 days ago, 293 - more than 15 days ago. Positive correlation between the number of days after alcohol intake and serum viscosity ($r = +0.1$; $p = 0.039$) and plasma viscosity ($r = +0.13$; $p = 0.004$) was established. The correlation between the studied factor and plasma viscosity in men aged 40-59 ($r = +0.24$; $p = 0.041$) was more closed. Diagram of this correlation is presented in Figure 1.

73 women indicated recent alcohol intake (1-3 days before the examination). Not more than a week ago (4-7 days before the examination) alcohol was taken by 60 women. 61 women indicated alcohol intake from 8 to 14 days ago, 301 women - more than 15 days. Dependence between the remoteness of alcohol intake and indices of hemorheology was not revealed in women. Thus, recent alcohol intake is associated with decrease in serum and

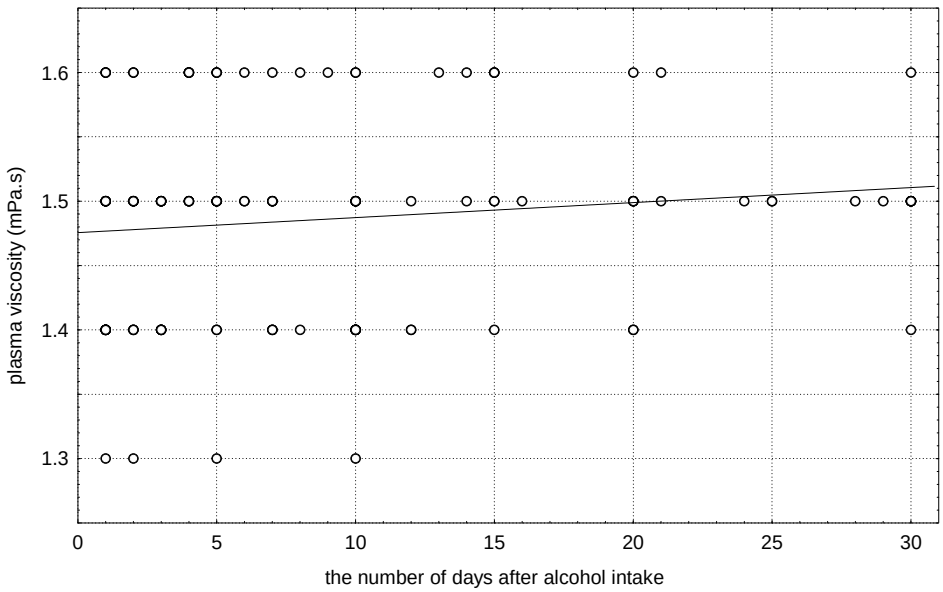

Fig.1. Correlation form between the number of days after alcohol intake and plasma viscosity in men aged 40-59, $n = 153$ (*Spirmen* $r = +0.24$; $p = 0.041$).

plasma viscosities. It has been demonstrated in investigation in a Japanese population that fibrinogen concentration lowered after the recent alcohol intake in men, but no correlations were determined in women [4].

Regular weekly alcohol intake was observed in 40 men (mainly aged 35-59 years) and in 12 women. 233 men and 195 women demonstrated monthly frequency of alcohol intake. Irregular intake (rarely than once a month) was found in 236 men and 319 women. Positive correlation between frequency of alcohol intake and whole blood viscosity was revealed in men ($r = +0.14$; $p = 0.001$). Correlation between frequency of intake and erythrocytes deformation index ($r = – 0.154$; $p = 0.001$) in men was negative. Women indicated positive correlation between frequency of alcohol intake and serum viscosity ($r = +0.153$; $p = 0.001$).

Thus, development of alcohol dependence in men (in the form of weekly alcohol intake) changes rheologic properties of the whole blood (raises viscosity and lowers pseudoplasticity). There are contradictory data, concerning the effect of alcohol on blood rheology. Probably, it was connected with the character of investigations: study of an episode of alcohol intake and cases of chronic habit development. It is known that immediately after alcohol intake, blood viscosity increases in subjects and in animal experiments [6,7,8]. Although in abuse of alcohol decrease of blood and fibrinogen viscosities was found [9]. Our data in the part of men and women, taking alcohol frequently, corresponded to the results of other population investigation, connected with analysis of alcohol intake [5].

Correlation analysis was conducted between the frequency of alcohol intake and indices of hemorheology in age groups (by 10-year life periods) for revealing the effect of alcohol dependence duration on rheologic blood properties. In the age group of 17-19 years two subjects indicated weekly alcohol intake. That is why regular monthly alcohol intake was compared with the episodic one. In youths negative correlation between the frequency of alcohol intake and erythrocytes aggregation index ($r = – 0.28$; $p = 0.01$) was found. In girls negative correlation between the studied factor and erythrocytes deformation index ($r = – 0.416$; $p = 0.001$) was observed. Girls also demonstrated positive correlation with serum ($r = +0.565$; $p = 0.001$) and plasma ($r = +0.302$; $p = 0.01$) viscosities. It has been concluded that at the age of 17-19 years alcohol intake is associated with decrease of the whole blood pseudoplasticity (at high shear rates – in girls, at low shear rates – in youths). In

men aged 20-39 positive correlations between the frequency of alcohol intake and the whole blood viscosity (r = +0.288; p = 0.009), plasme viscosity (r = +0.234; p = 0.031) were revealed. There is negative correlation of the studied factor with erythrocytes deformation index (r = – 0.374; p = 0.001); positive one – with erythrocytes aggregation index (r = +0.325; p = 0.003). Women of this age period indicated correlation between the studied factor and the whole blood viscosity (r = +0.144; p = 0.006).

In the second period of maturity (40-59 years) regular alcohol intake leads to increase of the whole blood viscosity in men (r = +0.256; p = 0.02), as well as in women (r = +0.178; p = 0.013). At elderly age regularity in alcohol intake by men and women effects viscosities of blood and its components (plasma, serum). In elderly men (older than 60) positive correlations between the frequency of alcohol intake and serum (r = +0.275; p = 0.009), plasma (r = +0.329; p = 0.001), blood (r = +0.448; p = 0.001) viscosities were revealed. In elderly women positive correlations between this factor and serum (r = +0.311; p = 0.047), plasma (r = +0.424; p = 0.001), blood (r = +0.475; p = 0.001) viscosities were observed. Thus, duration of alcohol dependence is connected with change in blood hemorheology. Weekly alcohol intake in youths (17-19 years) causes decrease in the whole blood pseudoplasticity only. At mature age weakness for alcohol induces increase in the whole blood viscosity. At elderly age close correlation between the frequency of alcohol intake and the whole blood viscosity was determined.

Conclusions

1. Change in plasma and serum viscosities, depending on the character of alcohol intake makes the basis of alcohol intake effect on rheologic properties of the whole blood (viscosity, pseudoplasticity). Alcohol intake before the examination decreases serum and plasma viscosities. Weekly alcohol intake by men and women of all age periods leads to increase in serum and plasma viscosities.
2. Development of alcohol dependence is connected with change in rheologic properties of the whole blood (viscosity increase and pseudoplasticity decrease). Weekly alcohol intake by youths and girls (17-19 years) lowers the whole blood pseudoplasticity. At mature age weakness of subjects for alcohol leads to increase in the whole blood viscosity. At elderly age there is close correlation between the frequency of alcohol intake and viscosity of the whole blood.

References

1. RAZARI D., GANDEK B. Testing Durch and French translacion of the SF-36 health survey among Belgian angina patients. **J Clin Epidemiology**, 51 (11): 975–983, 1998.
2. ЛОПУХИН Ю.М., ПАРФЕНОВ А.С., ДОБРОВОЛЬСКИЙ Н.А., ПЕШКОВ Ф.И. Анализатор крови реологический АКР-2. Определение реологических свойств крови. Методические рекомендации. Научно-исследовательский институт физико-химической медицины Министерства Здравоохранения Российской Федерации**,** 1994 (in Russian).
3. GLANTZ S.A. **Primer of biostatistics**. New York, McGraw-Hill, 1994.
4. ISHIKAWA S., KARIO K., NAGO N., KAYBA K., HIRAOKA J., MATSUO H., GOTO T., MIYAMOTO T., TSUTSUMI A., NAKAMURA Y., SHIMADA K., INOUE K., IGARASHI M. Factor VII and fibrinogen levels examined by age, sex, and other atherosclerotic risk factors in a Japanese population. **Thromb-Haemost**, 77(5): 890-893, 1997.
5. SANTOLARIA F., CASTILLA A., GONZALEZ R..E., PEREZ R.JC., RODRIGUEZ G.C., LOPEZ P.A., de MIGUEL J.E. Alcohol intake in a rural village: physical signs and biological markers predicting excessive consumption in apparently healthy people. **Alcohol**, 14(1): 9-19, 1997.
6. ВАШЕТКО Н.П. Влияние алкоголя на физико-химические свойства крови животных. Тезисы докладов 4-го Всероссийского съезда физиологов. Харьков, 57-58, 1930 (in Russian).

7. ПАЮ К.Л. Изменения реологических свойств крови при острой интоксикации этиловым алкоголем. Автореферат диссертации на соискание ученой степени кандидата медицинских наук. Тарту, 1985 (in Russian).
8. GALEDA G., DAVIDSON R.J.L. Some haemorheological and haematological effects of alcohol. **Scand J Haematol**, 30(4): 308-310, 1983.
9. MEADE T.W., CHAKRABARTI R., HAINES A.P. Characteristics affecting fibrinolytic activity and plasma fibrinogen concentrations. **Br Med J,** 1: 153-156, 1979.

АНАЛИЗ ЗАВИСИМОСТИ МЕЖДУ ХАРАКТЕРОМ УПОТРЕБЛЕНИЯ АЛКОГОЛЯ ВЗРОСЛЫМИ ЛЮДЬМИ И РЕОЛОГИЧЕСКИМИ СВОЙСТВАМИ ЦЕЛЬНОЙ КРОВИ

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Алкоголь является психотропным веществом, используется для снятия физического и психологического дискомфорта. Прием алкоголя вызывает множество клинических эффектов, в том числе изменение системной и местной гемодинамики. Целью настоящей работы явилось изучение связи между характером употребления алкоголя взрослыми людьми и изменением реологии цельной крови при моделировании биомеханических условий реального сосудистого русла. Были поставлены следующие задачи: 1) измерить показатели реологических свойств цельной крови и оценить характер употребления алкоголя в большой выборке взрослых людей различных возрастных периодов; 2) оценить связь между характером употребления алкогольных напитков и реологическими свойствами цельной крови. Изучаемые переменные: количество дней, прошедших после последнего приема алкоголя, частота употребления алкоголя (еженедельно, ежемесячно, еще реже), показатели гемореологии (вязкость и псевдопластичность цельной крови, вязкость плазмы и сыворотки).

Объект исследования – люди в количестве 984 человека (489 мужчин и 495 женщин) в возрасте от 17 до 94 лет. Критерий включения в исследование: возраст старше 17 лет. Критерий исключения: лечение в стационаре или поликлинике. Подбор участников исследования проводился среди добровольцев. Добровольцы для участия в исследовании набирались из различных мест: место работы или учебы; место прохождения ежегодного осмотра служащих, учителей, медицинских работников, некоторых категорий рабочих, ветеранов труда; донорский пункт, дома ветеранов труда. Характер употребления алкоголя изучали по ответам на вопросы анкеты. Давность последнего приема алкоголя определяли по вопросу: «Сколько дней назад Вы употребляли алкоголь?» и оценивали по количеству дней, указанных респондентом. Частоту приема алкоголя изучали по варианту ответа на вопрос «Укажите регулярность употребления алкоголя: еженедельно; ежемесячно; еще реже». Еженедельное употребление алкоголя оценивали в 3 балла, ежемесячное употребление – в 2 балла, еще реже – в 1 балл. Объем и качество употребляемого алкоголя не учитывался. Забор венозной крови осуществлялся в химически чистые пластиковые пробирки из локтевой вены в положении сидя. Стабилизатором являлся водный раствор 3,8%-го цитрата натрия в соотношении 9:1. Измерения проводились в течение 4 часов после венепункции. Кровь до измерения хранилась в холодильнике при температуре от +4° до +10°С. Измерение показателей проводилось из одной взятой порции крови. Вязкость цельной крови измеряли на ротационном вискозиметре АКР-2 (Москва, 1997 г.) при скоростях сдвига 200, 100 и 20 $с^{-1}$. Индекс деформируемости эритроцитов представлял

собой частное от деления вязкости крови при скоростях сдвига 100 $с^{-1}$ и 200 $с^{-1}$. Индекс агрегации эритроцитов представлял собой частное от деления вязкости крови при скоростях сдвига 20 $с^{-1}$ и 100 $с^{-1}$. Вязкость плазмы и сыворотки определяли на АКР-2 при скорости сдвига 100 $с^{-1}$. Вязкость крови и ее компонентов измеряли при температуре термостатирования анализатора + 37° С. В статистической обработке использовали коэффициент ранговой корреляции Спирмена для оценки достоверности нулевой гипотезы об отсутствии линейного характера связи между двумя переменными. Характер изучаемых переменных: независимые – количество дней, прошедших после последнего приема алкоголя, балл оценки частоты употребления алкоголя; зависимые – показатели гемореологии (вязкость цельной крови при скорости эритроцитов сдвига 100 $с^{-1}$, вязкость плазмы, вязкость сыворотки, индекс агрегации эритроцитов, индекс деформируемости эритроцитов). Минимальный уровень статистической значимости был $p < 0.05$. Статистический анализ проводился с помощью программ «Statistica'99» (Версия 5,5 А., «Statsoft, Inc.», г. Москва, 1999); «Biostat» (Версия 4,03, «Primer of Biostatistics, 1998», Практика, г. Москва, 1998).

Результаты исследования показали, что в основе эффекта от приема алкоголя на реологические свойства цельной крови (вязкость, псевдопластичность) лежит изменение вязкости плазмы и сыворотки, зависящее от характера употребления алкогольных напитков. Употребление алкоголя за день до исследования снижает вязкость сыворотки и плазмы. Еженедельный прием алкогольных напитков мужчинами и женщинами всех возрастных периодов приводит к повышению вязкости сыворотки и плазмы. Развитие алкогольной зависимости связано с изменением реологических свойств цельной крови (повышением вязкости и снижением псевдопластичности). Еженедельный прием алкогольных напитков юношами и девушками (17-19 лет) снижает псевдопластичность цельной крови. У людей зрелого возраста пристрастие к алкоголю приводит к повышению вязкости цельной крови. В пожилом возрасте существует тесная связь между частотой приема алкоголя и вязкостью цельной крови. Библ. 9.

Ключевые слова: алкоголь, реология крови, эксперимент

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