

Effect of ethanol on transfer factor: the importance of posture

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Pulmonary diffusing capacity for carbon monoxide (transfer factor, TLCO) is known to be low in alcoholics,¹ and ethanol may cause a reduction in TLCO in normal subjects.² The mechanism of this reduction is unclear, but there are two possible explanations. Firstly, a redistribution of blood may occur between the central and peripheral vasculature, causing a fall in pulmonary capillary blood volume (Vc). Secondly, there may be a change in the function of the alveolar capillary membrane (DM). Distinction between these two possibilities is important as it has been claimed on the basis of the alcohol induced reduction in TLCO that ethanol is directly toxic to the pulmonary alveolar capillary membrane.² To elucidate the mechanism of the fall in TLCO after ethanol we measured TLCO, Vc, and DM in normal subjects in both the erect and supine positions, before and 90 minutes after taking ethanol.

Methods

We studied 12 normal men aged 21-53 (mean 31) years; three were ex-smokers and nine had never smoked. All were in good health. They fasted from midnight on the day before the study. All experiments started at 1 pm. The subject lay flat on an examination couch or sat upright on a chair for 10 minutes before the measurements were carried out. TLCO was measured in duplicate by the single breath method described by Ogilvie *et al.*³ All measurements were made at total lung capacity (TLC). The order in which measurements were made (that is, whether the subjects were sitting or supine) was assigned randomly. The subjects then drank 1.5 ml of gin (45% ethanol) per kg body weight diluted with an equal volume of fruit juice. The measurements were repeated after 90 minutes and blood was drawn for determination of serum ethanol and haemoglobin concentrations.

Initially we studied TLCO alone in five subjects to see if we could repeat the previously observed fall after ethanol. Data from these subjects (not shown separately) convinced us that there was a fall. In the subsequent seven subjects we measured DM and Vc in addition to TLCO. Subjects in whom DM and Vc were measured did not differ in any way from the group as a whole. DM and Vc were measured in the sitting and supine positions by the technique of Roughton and Forster.⁴ In this method TLCO is measured in duplicate with trace concentrations of carbon monoxide in air and in 80% oxygen.

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Accepted 19 January 1987

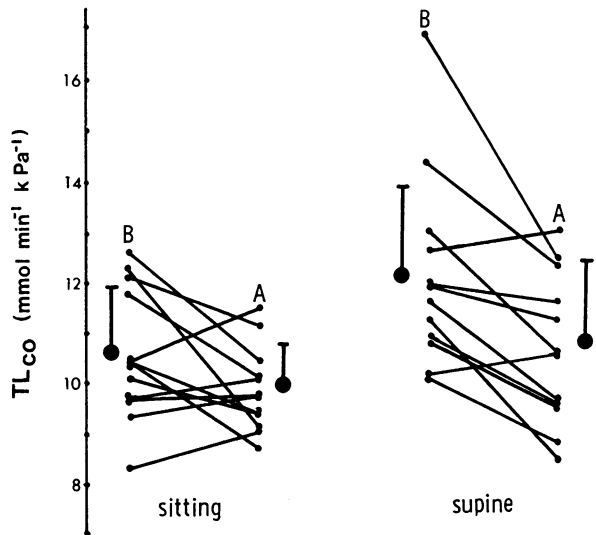


Fig 1 Transfer factor TLCO measurements before (B) and after (A) ethanol in 12 normal subjects determined in sitting and supine positions. Large symbols indicate group means and standard deviations. Statistical analysis by Student's paired *t* test gave values of $p > 0.05$ in the sitting position and $p < 0.02$ in the supine position.

Results

In preliminary experiments the variability of the tests was assessed. TLCO was measured in four subjects on at least eight occasions each, and the coefficient of variation was less than 7%. Vc and DM were measured in one subject on 12 occasions with coefficients of variation of 11% and 21% respectively. TLCO was within the predicted normal range for all subjects, and values of DM and Vc were similar to those previously reported.⁵ Effective alveolar volume was larger in the sitting position (mean (SD) 6.1 (1.4) l) than the supine (5.9 (1.0) l), but it did not vary with inhaled oxygen concentration and did not change after ethanol. All subjects absorbed sufficient ethanol to give detectable concentrations; at 90 minutes the mean serum ethanol concentration was 54 (range 38-68) mg/100 ml.

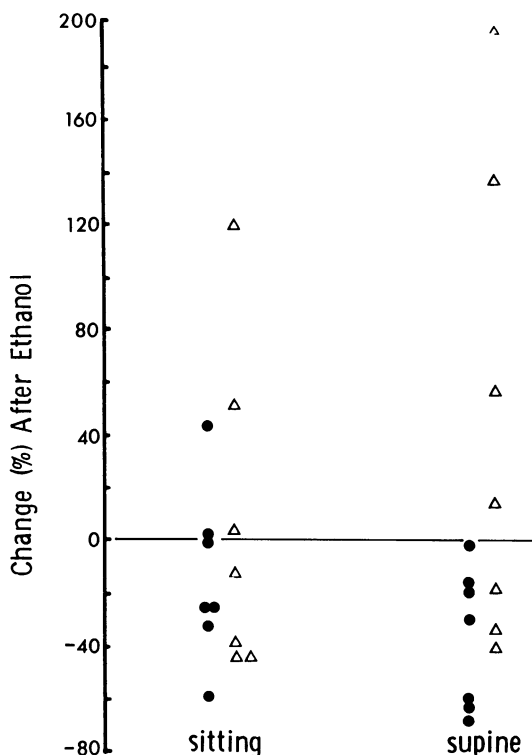


Fig 2 Percentage change in DM (Δ) and VC (\bullet) in individual subjects after ethanol in sitting and supine positions in seven normal subjects.

A significant drop in TLCO from 11.9 (SD 1.9) to 10.6 (1.2) $\text{mmol min}^{-1} \text{kPa}^{-1}$ was noted in the supine position 90 minutes after ethanol ($p < 0.02$ by paired t test) (fig 1). A much smaller drop from 10.5 (1.2) to 9.8 (0.8) $\text{mmol min}^{-1} \text{kPa}^{-1}$ was found in the sitting position and this was not significant.

There was a significant fall in Vc from 144 (SD 84) to 75 (15) ml in the supine position ($p < 0.05$). The fall in Vc in the sitting position (95 (44) to 76 (33) ml) was not significant. DM did not change significantly after ethanol in either the supine or sitting position (fig 2).

Discussion

Our results showing a mean reduction of 11% in TLCO when this was measured in the supine position 90 minutes after ethanol ingestion agree closely with those of Peavy *et al.*,²

who found a mean fall of 14% one hour after ethanol. They reported measurements made only in the supine position. Our subjects were studied both sitting and supine and we found a much smaller change in the sitting position. There is therefore an important positional effect on the reduction in TLCO induced by ethanol. Our results show a failure of the expected physiological increase in TLCO with the change from sitting to supine positions after ethanol.

The normal rise in TLCO on lying down is thought to be due to an increase in pulmonary capillary blood volume.⁵ Ethanol causes an increase in cardiac output at blood concentrations similar to those found in this study,⁶ and it causes peripheral vasodilatation. Probably this results in a shift of blood from the pulmonary to the peripheral circulation. This may be more pronounced in the supine position because of the greater resting vasomotor tone in the upright posture.⁷ This suggestion is supported by our measurements of DM and Vc. Although there was considerable variation in DM between individuals, the results for any one individual were consistent and did not decrease after ethanol. In contrast, Vc closely followed the change in TLCO, showing a significant fall in the supine position.

The fall in Vc, together with the important effect of posture on the changes in TLCO brought about by ethanol, lead us to conclude that the effect of ethanol on TLCO is mediated by a change in pulmonary capillary blood volume.

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