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ALCOHOL ABSORPTION, GASTRIC EMPTYING AND A BREATHALYSER

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1 The value of a portable breathalyser (Alcolmeter AE-M2) in the assessment of gastric emptying after alcohol ingestion was investigated by comparing breath and venous blood alcohol concentrations with simultaneous scintigraphic measurements of gastric emptying rate.

2 Alcohol absorption, as determined by the area under the venous blood alcohol concentration-time curve during the first 30 min, correlated with gastric emptying during the same period, implying dependence of the rate of alcohol absorption on gastric emptying rate.

3 There was no correlation between breath and venous alcohol concentrations during the first 15 min after alcohol ingestion, but a significant correlation was observed thereafter.

4 Breath alcohol measurements may be sufficient to detect gross alterations in gastric emptying but measurements of venous blood alcohol are likely to be more reliable.

Introduction

Gastric emptying rate measurements in man are usually based on contrast radiography, aspiration techniques or radioisotopic methods. All three approaches have disadvantages or limitations (Sheiner, 1975; Cooperman & Cook, 1976). Contrast radiography can detect gross abnormalities but the only measurement possible is the time to complete emptying. Gastric or duodenal aspiration methods provide a direct approach but are invasive and often disliked by patients. Studies of gastric emptying using scintigraphic techniques necessarily expose the subject to radiation and depend on the availability of a gamma camera or rectilinear scanner.

Finch, Kendall & Mitchard (1974) attempted to overcome some of these difficulties when they described a technique for the assessment of gastric emptying using a breathalyser, an instrument which estimates the alcohol concentration in blood from that in expired air. It was assumed that the rate of alcohol absorption is dependent on the rate of gastric emptying since alcohol absorption occurs principally from the small bowel (Rinkel & Myerson, 1941; Kalant, 1971; Hillbom & Wallgren, 1978) and therefore altered rates of delivery of alcohol from the stomach to the small bowel should be reflected in altered rates of alcohol absorption.

In this paper we describe an investigation of the relationship between gastric emptying and alcohol absorption. Simultaneous measurements of breath and venous blood alcohol were performed to assess alcohol absorption and gastric emptying was determined directly by sequential scintiscanning.

Methods

The breathalyser

The instrument (Alcolmeter AE-M2, Lion Laboratories Ltd, Cardiff) is a portable device contained within a small attache case. It consists of a sensor, a breath sampling valve, an amplifier and a display meter. When the sample button is pressed the alcohol present in the measured end expiratory sample (1.0 ml) is oxidised by an electrode to acetic acid. This electro-chemical oxidation produces an electrical potential which is amplified and displayed directly on the meter as a venous blood alcohol concentration (mg/100 ml). On each occasion before the instrument was used, calibration was checked by passing known concentrations of alcohol vapour through the detachable mouthpiece.

Gastric emptying and alcohol absorption

Alcohol absorption and gastric emptying were measured simultaneously in nine informed male volunteers, four of whom were healthy subjects and five of whom were patients with a past history of duodenal ulceration. The five patients were symptom free at the time of study. None of the subjects was receiving medication known to influence the rate of gastric emptying. All drank alcohol on social occasions but alcohol was not permitted for 48 h before the commencement of the study. The mean age of the nine subjects was 40.6 years (range 23–55 years).

After an overnight fast each subject drank orange

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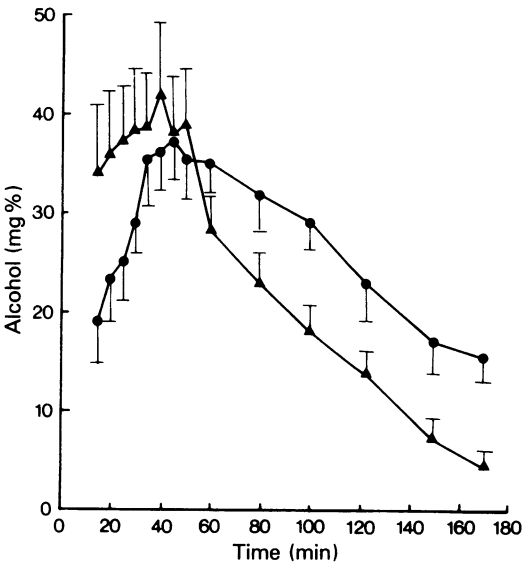

Figure 1 Blood alcohol concentration-time curves (mean ± s.e. mean) derived from gas liquid chromatographic analysis and breath alcohol analysis in nine subjects. ▲ breath alcohol, ● venous alcohol.

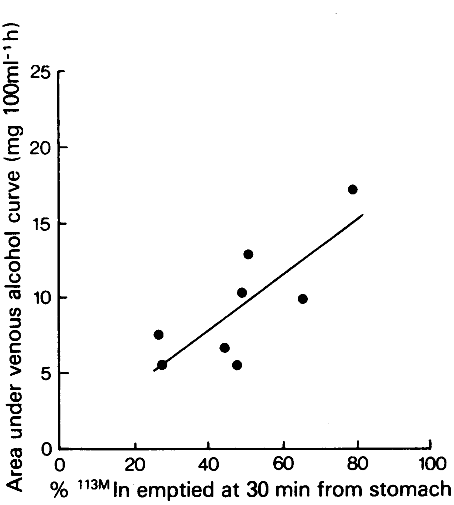

Figure 2 Area under venous alcohol concentration-time curve (gas liquid chromatographic analysis) at 30 min plotted against percentage of ingested solution emptied from the stomach at 30 min in eight subjects.

juice (400 ml) containing ethanol (0.5 mg/kg) and the chelate of indium-113 m with diethylene triamine penta-acetic acid as a non-absorbable marker for the measurement of gastric emptying. On each occasion 5 min was allowed for the consumption of the test solution. The mouth was then thoroughly rinsed with water. The breathalyser was used to estimate blood alcohol concentrations at intervals up to 3 h after alcohol ingestion and venous bood samples were taken simultaneously. Plasma alcohol concentrations were determined within 20 min of collection by gas liquid chromatography and a correction was applied to estimate values for whole (venous) blood alcohol (Payne, Foster, Hill & Wood, 1967). Tobacco, fluid and food were withheld throughout the study and the subjects were asked to restrict talking to a minimum.

Gastric emptying rates were measured by sequential scintiscanning, using a modification of a method previously described (Heading, Tothill, Laidlaw & Shearman, 1971). The subjects remained seated between scans, which were performed with the subject supine. Successive abdominal scans were digitised by computer and the counts in a selected area, which included the stomach, was determined, Appropriate corrections were made for background and for physical decay of ^{113m}In. A plot of logarithm of counts against time was then drawn, complete ingestion of the alcohol test solution being taken as zero time. Gastric emptying results were expressed as the percentage of ingested solution emptied from the stomach in thirty minutes.

Results

Blood alcohol concentrations, determined directly and with the breathalyser are plotted together in Figure 1. From 0–15 min after ingestion of the test solution the breathalyser recorded higher concentrations in all subjects and there was no significant correlation between the two measurements ($r=0.26$). From 20–180 min, a significant correlation was observed ($r=0.63$, $P<0.001$).

To compare the rate of gastric emptying with the rate of alcohol absorption, the area under the venous blood alcohol concentration-time curve during the first 30 min was compared with the percentage of ingested ^{113}In. emptied from the stomach at 30 min. In one subject, a technical fault occurred in the scanning procedure so that a measurement of gastric emptying was not obtained. A positive correlation between alcohol absorption and gastric emptying was observed in respect of the other eight subjects ($r=0.78$, $P<0.025$) (Figure 2). The area under the alcohol concentration time curve as determined using the breathalyser was similarly compared with the percentage of test solution emptied at 30 min, but a statistically significant positive correlation was not present ($r=0.52$, $P>0.05$).

Discussion

Considerable interest has been focussed on the relationship between gastric emptying and drug absorption rate (Levine, 1970; Prescott, 1974; Finch *et al.*, 1974; Nimmo, 1976). In man, absorption of many drugs from the stomach is negligible and the rate of gastric emptying controls the delivery of a drug to the maximal site of absorption in the small bowel (Levine, 1970). The present results demonstrate directly that the rate of alcohol absorption correlates with the rate of gastric emptying and therefore support the suggestion that the absorption kinetics of alcohol might be used as an indicator of gastric emptying rate in man (Finch *et al.*, 1974; Bateman, Kahn, Mashiter & Davies, 1978).

It has been recognised that factors which increase gastric emptying rate increase alcohol absorption rate and produce high blood alcohol levels (Fleming, Haynes & LeQuesne, 1971; Gibbons & Lant, 1975). Cotton & Walker (1973) studying ethanol absorption after gastric operations and in patients with coeliac disease demonstrated rapid absorption in the patients who had undergone partial gastrectomy and delayed absorption in patients with coeliac disease compared with controls. We have recently observed a delay in the rate of gastric emptying and paracetamol absorption in patients with coeliac disease (Holt, Heading, McLoughlin & Prescott, 1979) and thus slower gastric emptying may have contributed to the delay in alcohol absorption observed in patients with coeliac disease by Cotton & Walker (1973).

A demonstration of the dependence of the rate of alcohol absorption on the rate of gastric emptying suggests that a breathalyser might be useful for the assessment of gastric emptying rate. However, there are limitations. Early phases of gastric emptying cannot be assessed because spuriously high breath alcohol readings occur up to 15 min after alcohol consumption, presumably due to contamination of the oro-pharynx by ingested alcohol (Bogen, 1927; Jones, 1974).

Use of a portable breathalyser may be sufficient to detect gross changes or abnormalities in gastric emptying (Finch *et al.*, 1974; Hall, Brown, Carter & Kendall, 1976) but the measurement of venous blood alcohol concentrations would seem to be a better method. However, we suggest that neither is likely to be as useful as a direct measurement of gastric emptying rate when precision is required.

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