Comparison of ^{14}C -labelled polyethylene glycol (PEG) with carrier PEG and ^{14}C -PEG alone as a volume indicator in the human jejunum

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SUMMARY ^{14}C -labelled polyethylene glycol (PEG) (5 $\mu\text{Ci/l}$) was used as a non-absorbable marker in human jejunum both with and without carrier PEG (5 g/l). Calculation of net water flux was virtually identical whether or not the carrier PEG was included in the perfusion solution. ^{14}C -PEG alone is a satisfactory non-absorbable marker for perfusion studies in the human jejunum.

Intestinal perfusion using polyethylene glycol as a non-absorbable volume indicator is used widely as a technique for assessing absorption in man (Cooper *et al.*, 1966; Soergel, 1971). These studies rely on sensitive, accurate, and reproducible assays of marker concentrations. The turbidimetric analysis of PEG (Hydén, 1956) is laborious and time-consuming. Because of this, Wingate *et al.* (1972) compared the validity of using stable and ^{14}C -labelled PEG as a marker and found that measuring ^{14}C -labelled PEG was simple and yielded similar estimates of water absorption or secretion. They have suggested the use of a combination of radioactive PEG with carrier PEG to obtain accurate results. The present study was undertaken to assess whether the stable carrier PEG is indeed essential for accurate assessment of intestinal fluxes in man.

Methods

Eight healthy human volunteers who gave informed consent were studied.

After an overnight fast of 12 hours the small bowel was intubated with a modified triple lumen polyvinyl tube (Schmitt *et al.*, 1974) and positioned under fluoroscopic control so that infusion point was just distal to the ligament of Treitz. Openings of the proximal and distal aspiration tubes were located 15 and 45 cm distal to the infusion point. Two con-

secutive experiments, each lasting 120 minutes with one or other of the test solutions, were undertaken in each subject. Sixty minutes were allowed for equilibration followed by a 60 minute test period with each solution.

All perfusion fluids had the following composition (mmol/l) sodium 135, potassium 5, chloride 105, and bicarbonate 35. ^{14}C -labelled polyethylene glycol (New England Nuclear Corporation) was added to both solutions to give a concentration of 5 $\mu\text{Ci/l}$ and carrier PEG (Carbowax 4000, Union Carbide Corporation, molecular weight approximately 4000, 5 g/l) was added to the second solution only. Four subjects received the solution containing carrier PEG first, followed by the solution without carrier PEG. The order was reversed in the other four subjects. The solutions were perfused at the rate of 9 ml per minute. Samples were collected from the proximal and distal aspiration points at the rate of 1 ml per minute with a 15 minute stagger period between the proximal and distal collections (Whalen *et al.*, 1966).

Aliquots were taken for measurement of ^{14}C -labelled PEG, which was performed in a Packard Tricarb liquid scintillation spectrometer. One millilitre of aspirate was digested with Soluene 350, decolourised with isopropanol and hydrogen peroxide (30-35%) at 40°C, and then mixed with Dimilume scintillator fluid before counting. The efficiency of counting was 92% $\pm$ 2% as assessed by external standardisation of increasingly quenched ^{14}C standards.

Net transport of water was determined by standard formulae for the 30 cm study segment using PEG corrections. Results are expressed as ml cm⁻¹ h⁻¹.

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Mean results are expressed $\pm$ the standard error of the mean and statistical comparisons were carried out by the paired Student's *t* test.

Results

There was an excellent correlation between net water flux calculated from data using ^{14}C -PEG with and without carrier PEG (Figure) ($r=0.97$, $P < 0.001$). Mean results using the two test solutions were virtually identical (Table) ($t = 0.13$, $P = > 0.7$).

Figure Correlation between net water flux calculated from ^{14}C -PEG data with and without carrier PEG.

Table Net water flux in eight patients calculated from ^{14}C -PEG data with and without carrier PEG

Patient no.	^{14}C -PEG with carrier $\Delta \text{H}_2\text{O ml cm}^{-1} \text{h}^{-1}$	^{14}C -PEG without carrier $\Delta \text{H}_2\text{O ml cm}^{-1} \text{h}^{-1}$
1	2.03	2.06
2	1.50	1.73
3	1.42	1.23
4	1.97	2.04
5	1.02	0.90
6	0.88	0.76
7	1.32	1.42
8	0.88	0.79
Mean $\pm$ SEM 1.38 $\pm$ 0.16		Mean $\pm$ SEM 1.37 $\pm$ 0.19

Discussion

This study has shown that ^{14}C -labelled PEG may be used without carrier PEG in the investigation of jejunal water transport in man. This has been previously documented in the rat by Miller and Schedl (1970) who found a 96% recovery of marker with a perfusing solution containing ^{14}C PEG with or without stable PEG. Domschke *et al.* (1973) have also demonstrated that ^{14}C -PEG alone is an adequate marker for estimation of gastric volume in man.

As ^{14}C -PEG is easily analysed, well recovered, and essentially non-absorbed, it admirably fulfils the criteria of a satisfactory volume marker for gut perfusion studies. Furthermore, the radiation energy of ^{14}C is low, and the small doses of ^{14}C -PEG used make the exposure to ionising radiation negligible.

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