J. Pharm. Pharmacol. 1988, 40: 595–596
Communicated February 23, 1988

Oesophageal transit of small tablets

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Abstract—Oesophageal transit has been studied in six asymptomatic subjects aged 29–80 years. Using gamma scintigraphy, the transit of a liquid and five small tablets was monitored in each subject. All the subjects exhibited normal liquid swallowing, with 50% oesophageal clearance times of less than 5 s. In three subjects all the tablets passed through the oesophagus within 6 s, but transit was prolonged in 60% of the swallows in the other subjects. Tablet hold up occurred more frequently in the elderly. An additional drink of water cleared all lodged tablets into the stomach. To minimize possible mucosal irritation, the taking of even small tablets should be followed by an additional drink of water.

Patients often complain of difficulty in taking tablets and it is accepted that tablets (Evans & Roberts 1976) and capsules (Fisher et al 1982) may lodge in the oesophagus, even in healthy subjects. The patient may, however, be unaware that the preparation has remained in the oesophagus for a prolonged period (Fisher et al 1982).

Many medicines have been identified that can damage the oesophageal mucosa. In the past emepronium bromide tablets (Barrison et al 1980), slow release potassium chloride tablets (Kikendall et al 1983), and doxycycline (Crowson et al 1976) were common offenders. Currently non-steroidal anti-inflammatory analgesics are believed to be a major cause of the steadily increasing incidence of drug-induced oesophageal injuries (Heller et al 1982). Oesophagitis may develop, with retrosternal pain and dysphagia, and this may progress to ulceration and stricture formation. Deaths have resulted from drug-induced perforation or haemorrhage (Collins et al 1979). Factors stated to improve the oesophageal transit of a capsule are erect posture, a lubricating drink before swallowing the capsule (Fisher et al 1982) and a large volume drink with the capsule (Channer & Virjee 1982).

This study investigates the oesophageal transit of small tablets in subjects with no symptoms of oesophageal dysfunction and relates tablet transit with age.

Methods

Oesophageal transit studies were undertaken in six subjects, five men and one woman, aged 29–80 years. None of the subjects had any symptoms or history of upper gastrointestinal disease. Each provided written, informed consent and the study was approved by the Hospital Ethical Committee.

The non-disintegrating tablets were 4 mm diameter by 4 mm thick and had a mass of 0·06 g. Each tablet was radiolabelled with 0·2 MBq indium-111 and coated with cellulose acetate.

After an overnight fast each subject consumed a breakfast of fruit juice, toast with butter and marmalade, followed by a cup of tea. The oesophageal transit studies were carried out immediately after breakfast.

Imaging was undertaken using a gamma camera having a 40 cm diameter field of view, fitted with a medium energy (300 keV maximum), parallel hole collimator. Each subject was seated, facing the gamma camera with the whole of the oesophagus in the field of view. A solution of 4 MBq $^{99}Tc^{m}$-labelled diethylenetriaminepentaacetic acid ($^{99}Tc^{m}$-DTPA) in 10 mL water was administered into the mouth. The subject was asked to swallow the solution as a single bolus. Oesophageal transit was recorded by computer as a dynamic study of 60 images, each of 0·5 s duration.

After the solution transit study, an ^{111}In-labelled tablet was administered along with 10 mL water. The subject was instructed to swallow the tablet with the water; the transit being recorded as for the solution. The tablet swallow was repeated four times in each subject. On the occasions when the tablet remained in the oesophagus for more than 30 s an additional drink of 10 mL water was administered.

The images of each swallow were displayed on a television monitor and a region of interest defined around the oesophagus, avoiding the mouth and stomach. A time-activity plot was obtained and the oesophageal transit time calculated. For the $^{99}Tc^{m}$-DTPA solution the time for 50% clearance was obtained. Additionally, images were generated showing the changes in the vertical distributions of radioactivity in the oesophagus with time (Fig 1). These images allowed the sites of hold up in transit to be readily identified.

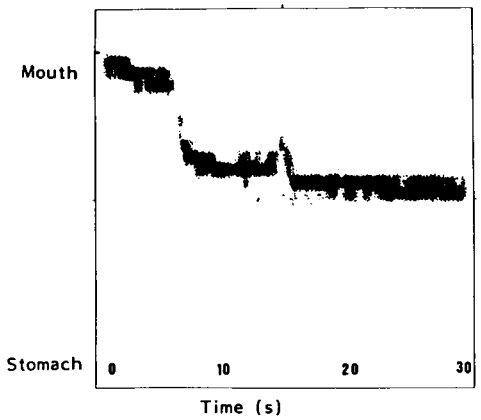

FIG 1. Swallowing pattern for a tablet, showing hold-up in the mid-oesophagus (Subject 6).

Results

The mean time for 50% of the $^{99}Tc^{m}$-DTPA solution to pass through the oesophagus was 3·4 s with a range of 2·2–4·6 s (Table 1). Tablet transit was recorded successfully for 26 of the 30 swallows. Seventeen tablets passed through the oesophagus within 6 s, seven took more than 30 s, and the remaining two, 18 and 21 s, respectively (Table 1). The other four tablets were swallowed slightly prematurely and passed rapidly through the oesophagus. In three subjects tablet transit was less than 6 s for all swallows, whilst transit was prolonged in 60% of the swallows in the subjects aged 59–80 years. None of the subjects were at any time aware of the presence of lodged tablets. An additional drink of 10 mL water cleared all lodged tablets into the stomach. The sites of tablet hold up were variable. In subject 5, one tablet

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Table 1. Oesophageal transit times.

Subject	Age (years)	Sex	Transit times (s) Liquid	Tablet
1	29	M	3·5	3
				*
				5
				4
				4
2	50	F	3·2	4
				3
				*
				2
				5
3	54	M	2·2	2
				*
				*
				3
				4
4	59	M	4·6	>30
				>30
				>30
				4
				4
5	72	M	4·4	3
				6
				>30
				>30
				>30
6	80	M	2·5	21
				<2
				18
				6
				>30

* Not recorded

arrested in the proximal oesophagus, one in the distal oesophagus and one passed slowly through the mid-oesophagus before lodging distally. In subject 6, two tablets lodged in the proximal oesophagus and one in the mid-oesophagus (Fig 1). The distal oesophagus was the site of hold-up of all three tablets with prolonged transits in subject 4. The sequence of the swallows resulting in tablet hold up was also variable.

Discussion

This study has confirmed previous findings (Evans & Roberts 1976; Fisher et al 1982) that it is common for solid pharmaceutical formulations to remain in the oesophagus for prolonged periods. The results indicate that hold up in oesophageal transit occurs most frequently in elderly patients, the group most likely to be taking tablets. This may in part explain why elderly patients are particularly at risk of sustaining drug-induced oesophageal injuries (Drug and Therapeutics Bulletin 1981).

None of the subjects experienced difficulty in swallowing food. The radiolabelled solution passed through the oesophagus rapidly in all the subjects. This drink served to outline the anatomy of the oesophagus and the gastric fundus and to lubricate the oesophagus before dosing with the first tablet. Additionally, each tablet was taken with water, since this has been shown to aid swallowing (Fisher et al 1982). A lack of adequate lubrication is unlikely to have caused the hold ups in the present study since there was no consistent pattern to the sequence of the swallows during which the tablets arrested. Patients are usually upright when they take tablets and this reduces the likelihood of lodging in the oesophagus (Channer & Virjee 1982). In the present study the subjects were seated for the swallows.

Overall, oesophageal transit of the tablets was delayed in 30% of the swallows in the present study. Tablets lodged at various levels within the oesophagus and the sites of hold up were unrelated to particular anatomical features. In the same individual hold up may occur at more than one site. These studies were performed on only one occasion and further studies would be necessary to investigate day to day variations in tablet transit. Liquid swallowing was normal and only some tablets lodged in the oesophagus, which may be related to the fact that the pharynx acts as a pump. Boluses of liquid are injected into the oesophagus, with peristalsis propelling remaining solids towards the stomach (Buthpitiya et al 1987). If the tablet is carried in the leading edge of the swallowed liquid bolus it may be swept rapidly through the oesophagus and into the stomach. If, however, it is swallowed with the trailing edge of the bolus it may be deposited in the oesophagus. The leading edge of a subsequent liquid bolus can readily clear the tablet into the stomach. In the elderly, peristaltic amplitude and co-ordination may be impaired and this may explain the delayed oesophageal transit and lodging of the tablets seen in the older subjects.

This study has demonstrated that lodging of small tablets in the oesophagus is a frequent occurrence. This seems to be a particular problem in the elderly. To minimize the likelihood of tablets remaining at the same site in the oesophagus for prolonged periods and possibly damaging the mucosa, tablets should be taken with water followed by an additional drink.

We thank Mr R Khosla and Mr I Wilding of the Department of Pharmacy, Nottingham University for the preparation of the tablets.

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