

## Transit through the distal quarter of the oesophagus in young children

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The transit time of 800 individual boluses through the distal quarter of the oesophagus was measured in 33 scintigraphic oesophageal studies which had been selected as typifying normal swallows in children. The results show that, in children, transit time through the distal quarter including the lower oesophageal sphincter is normally less than 2 seconds and that transit tends to be slower during the first 4 seconds after onset of swallowing.

**Key words:** oesophageal transit, scintigraphy, children

### INTRODUCTION

OVER THE PAST DECADE the management of abnormal oesophageal motility and gastro-oesophageal reflux (GOR) in children has received increasing attention.<sup>1–4</sup> Scintigraphy is widely used in the assessment of such patients and one of the problems to emerge is the difficulty in identifying normal physiological variability. We encountered particular difficulty interpreting transit in the region of the lower oesophageal sphincter (LOS). There is disagreement as to whether the LOS exists both as a functional and as an anatomical entity<sup>2,5</sup> making a precise measurement of its location problematic, but it is clear it occurs in the distal 25% of the oesophagus. This is a common site of abnormal transit in young children with GOR. The aim of this study was to document the variability in transit time of liquid boluses passing through the region of the LOS in young children who were thought to swallow normally.

### METHODS AND SUBJECTS

Well established scintigraphic techniques, described elsewhere, were used to study oesophageal transit.<sup>6,7</sup> <sup>99m</sup>Tc Sn Colloid was used as a radiotracer in 5 ml of milk, which the child drank whilst sitting on the mother's or nurse's lap in an erect position. The dose was 1.5 to 2.5 MBq per kg body weight with a maximum of 30 MBq. The swallow

was recorded as a dynamic sequence with one image every half second for one minute beginning just before the onset of swallowing. Images were captured in a 64 × 64 matrix in byte mode for 60 seconds on an Elscint Apex 415 system with a low energy medium resolution collimator (APC-3). In the measurement of transit time, and in the evaluation of whether recorded swallows were normal or not, three forms of image and time activity curves were examined. The images were the individual half second frames, a condensed image derived from the dynamic sequence<sup>8,9</sup> and a cine display of the 120 individual frames.

The data used in this study have been derived from an examination of 358 consecutive GOR scintigraphic investigations conducted at the Red Cross War Memorial Children's Hospital in Cape Town, South Africa, between July 1986 and June 1990. These investigations were only performed on those children who had GOR documented by conventional Barium radiography or in whom there were strong clinical grounds for suspecting GOR and who had subsequently been referred to the Department of Nuclear Medicine for scans. The need, therefore, for rigorous selection of normal swallows was recognized. The first stage was to exclude patients who had an anatomical abnormality demonstrated on Barium swallow or who did not have smooth and unhindered passage of every bolus through the proximal 75% of the oesophagus on scintigraphy. Patients who showed entry of Barium or radiotracer into the nasopharynx, larynx or trachea while swallowing were also excluded. The remaining studies were examined by each of the authors working independently. Thirty-three investigations were regarded

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**Table 1** Transit time in seconds of 800 swallows through the distal quarter of the oesophagus

Transit time seconds	Number of swallows
< 0.5	538
0.5-1	160
1-1.5	37
1.5-2	24
2-2.5	10
> 2.5	31

**Table 2** Mean transit time in seconds for passage through the distal quarter of the oesophagus in 33 children

Transit time seconds	Number of children
< 0.5	5
0.5-1	17
1-1.5	9
1.5-2	0
2-2.5	1
> 2.5	1

**Table 3** Variation of transit time in seconds through the distal quarter of the oesophagus in the first 16 seconds after the onset of swallowing

Seconds after start of swallowing	Transit time (seconds)	
	mean	SD
0-4	1.44	1.42
4-8	0.98	0.91
8-12	0.76	0.73
12-16	0.62	0.17

as normal by all observers. Twenty-five of the children were less than 1 year old and the remainder less than 2 years.

The 60 second dynamic sequences were used for the measurement of transit time through the LOS. All the infants had finished drinking the labeled milk by the end of the dynamic study and for each bolus the time of swallowing and the transit time through the distal quarter of the oesophagus were measured using the half second frames. One half second was thus the minimum resolution of measurements made in this study. No swallows were excluded and, in all, the transit times of 800 individual boluses were measured.

## RESULTS

In Table 1 the transit times of passage through the distal quarter of the oesophagus for each of the 800 individual swallows are presented. In the majority of cases these transit times were less than 0.5 seconds, with 67% less than 0.5 seconds and 95% less than 2.0 seconds. Table 2

summarizes the mean transit time for each of the 33 patients. As anticipated, from the results of the individual swallows, the mean time was less than 1.5 seconds in the vast majority (94%) of patients. Only two patients had mean times greater than 1.5 seconds and in four all recorded swallows took less than 0.5 seconds to pass through the distal oesophagus.

Table 3 shows the variation of transit time of the swallows which occurred in the first 16 seconds from the onset of swallowing. The 16 second time period was divided into four 4 second intervals and a mean time and standard deviation was derived for all 33 studies together, for each 4 second interval. Two trends are clear; firstly, the initial swallows take longer than 1 second to transit the LOS but this duration became shorter as swallowing progressed. Secondly, the variation was at a maximum closest to the onset of swallowing.

## DISCUSSION

Mean oesophageal transit time (OTT), that is the time for transit through the entire oesophagus, is often prolonged in the presence of oesophageal dysmotility, GOR, or other disorders interfering with deglutition.<sup>10,11</sup> Previous work has shown that the OTT is approximately 3 seconds for infants. The normal OTT increases with age, in part because of oesophageal growth during childhood and adolescence. Much of the observed variability occurs in the area of the LOS but there is very little in the literature that describes transit behaviour through this distal portion of the oesophagus in children as a function of time.

We perform all measurements on oesophageal transit in the erect position unless there are specific indications for studying a child supine, because most mothers feed babies in the erect or semi-erect position. It is therefore the "physiological" position in which the baby has learnt to swallow and normally feeds. In addition, most patients referred to us are thought to have a swallowing disorder or GOR and we advocate feeding and nursing these children in the erect position. Although the pharyngeal component of swallowing and gravity may mask some subtle transit abnormalities in the erect position, it is unlikely this is a major practical problem in the infants and young children referred to us for investigation. There were only 33 normal studies in this series of 358 consecutive patients.

In babies the number and timing of swallows cannot be controlled but most infants who have normal oesophageal transit swallow regularly, almost rhythmically, while drinking small volumes. We selected a standard volume of 5 ml on the basis of experience as being large enough to demonstrate the regular pattern of swallowing and provide information on repeated swallows in each patient. Offering smaller volumes with the same tracer specific activity has the advantage that the study can be repeated but weights the results in favour of the swallows which occur when the baby starts to drink. Larger volumes are

more difficult to analyze because the specific activity is lower. They also introduce other causes of variability such as pauses in drinking.

This study suffers from the inevitable problems associated with examining the abnormal (all 33 patients had GOR) in order to describe the normal, but data on normal infants are not readily available and very strict criteria were applied for the admission of each scintigraphic study used as representative of a normal swallow. This study demonstrates that the passage of liquid boluses through the region of the LOS in children drinking in the erect position is normally quick, less than 0.5 seconds. Ninety-five percent of swallows passed in less than 2 seconds, and, if the suggested mean OTT of 3 seconds for infants is acceptable, our data imply that boluses tend to spend at least half of the overall OTT in the region of the LOS. These data also reflect a pattern in sphincter tone which is a function of time. It is clear that the sphincter does close in infants, and, as expected, it tends to be closed during the initial phase of swallowing; but this varies a good deal. After this initial period the sphincter tends to remain open. It may open and close during the full duration of swallowing but with decreasing frequency and for shorter periods of time. When scintigraphic studies are performed in the erect position, holdup in distal quarter of the oesophagus is not pathological provided it occurs in the first few seconds after the child begins to swallow and is of short duration. Thereafter any holdup lasting more than 2 seconds is probably abnormal.

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