

Bursts of non-deglutitive simultaneous contractions may be a normal oesophageal motility pattern

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Abstract

The frequency and characteristics of non-deglutitive motor activity of the human oesophagus and its relation to motility patterns in the antrum and upper small intestine were studied in 25 fasted healthy subjects. Motility of the oesophagus, antrum, and upper small intestine was recorded by means of a manometric perfused catheter system. The most striking non-deglutitive motility pattern consisted of repetitive bursts of non-sequential pressure peaks occurring in the smooth muscle portion of the oesophagus. The mean number of pressure peaks per burst was 2.7 (SD 2) waves with a mean amplitude of 19.5 (SD 9.9) mm Hg and a duration of 3.09 (SD 0.22) seconds. The highest amplitude was 80 mm Hg and the longest burst consisted of 13 repetitive waves. The bursts were recorded up to a distance of 15–20 cm above the lower oesophageal sphincter. Ninety five per cent of the bursts occurred during a 15 minute period before the onset of phase 3 of the migrating motor complex in the antral or upper small intestinal area, or during the lower oesophageal sphincter component of the migrating motor complex. In conclusion, spontaneous bursts of non-sequential pressure peaks occurred in the smooth muscle part of the human oesophagus in relation to phase 3 of the migrating motor complex. They represent the oesophageal body component of phase 3 of the migrating motor complex and are not a sign of oesophageal motor abnormalities.

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Non-deglutitive motor activity of the oesophagus is usually considered to be a sign of disordered motility. There have been isolated reports indicating that spontaneous contractions unrelated to swallowing occasionally occur in the human oesophagus, particularly during phases 2 and 3 of the migrating motor complex.^{1,2} These contractions are often non-peristaltic. Recent studies with ambulatory pressure monitoring systems indicate that an appreciable number of non-peristaltic contractions are commonly found in apparently normal subjects.³ Now that 24 hour pressure recordings are used increasingly for the investigation of disorders of oesophageal motility in patients with chest pain of undetermined origin,⁴⁻⁸ it is important to have a better understanding and a more precise characterisation of the non-deglutitive and non-peristaltic motor activity of the normal oesophagus. Moreover, ambulatory oesophageal pressure recording systems have only two or three recording ports, so that the relation of oesophageal motility

to motor activity elsewhere in the gastrointestinal tract cannot be established.^{4,12}

The aim of this study was to determine the frequency and characteristics of non-deglutitive motor activity in the normal human oesophagus and to study the relation of this oesophageal motor activity to motility patterns elsewhere in the gastrointestinal tract.

Methods

Twenty five normal subjects (mean age 24 years, range 20 to 38 years; 20 men) were studied after an overnight fast of at least 10 hours. All subjects belonged to a group of volunteers who had previously participated in other studies and who were known to have normal oesophageal motility. All subjects were symptom free, were not taking any drugs, and agreed to collaborate as volunteers. The study was approved by the ethics committee of the university hospital.

Oesophageal pressures were measured with a low compliance perfused catheter system (Arndorfer Medical Specialists, Greendale, Wisconsin) containing six lumens. The catheters (0.8 mm internal diameter, 1.5 mm outside diameter) were perfused at a rate of 0.6 ml/min. Side openings measured pressures in the oesophagus at 5, 10, 15, and 20 cm above the lower oesophageal sphincter. This pressure was continuously monitored with a Dent sleeve¹³ and fundic pressure was also measured with a side opening 1 cm distal to the sleeve. The pressure changes captured by external transducers were amplified (E 0333E-E 154E, Siemens, Elema, Sweden) and recorded on paper with a polygraph (Mingograph 82; Siemens). Two carefully placed external electrodes (red dots, Ag/AgCl, 3M, Saint Paul, USA) recorded the electromyographic activity of the suprahyoid muscles and were used as a deglutition signal. In 10 of the 25 subjects, motor activity of the antrum, duodenum (15 cm distally to the antral recording site), and proximal jejunum (40 and 65 cm distally to the antral site) was also recorded simultaneously via a separate four lumen perfused catheter system. Both tubes were introduced via the nose and the position of the tubes was checked with a fluoroscope. The subjects were studied in the semirecumbent position and were not allowed to eat during the study. Before starting the study, pressures were recorded for 30 minutes to check the correct functioning of the recording system and to allow the subjects to accommodate to the catheters. Pressure tracings were analysed manually according to accepted criteria¹⁴ and by a specific computer program.^{15,16}

The first step in the analysis consisted of determining the deglutitive or non-deglutitive

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nature of all oesophageal pressure waves. The various characteristics of the individual waves were analysed by the computer program. Only pressure waves greater than the respiratory swing at that level were taken into account. The amplitude was measured from the midrespiratory basal pressure level to the peak of the pressure wave. The onset of the pressure wave was the point where the tangent of the sudden upstroke of the wave crossed the basal pressure. The end of the wave was determined in a similar way. A wave was considered to be peristaltic if the interval between the onset of two pressure waves, recorded at adjacent points 5 cm apart, was more than 0.5 seconds (corresponding to a progression velocity of less than 10 cm/s).

The lower oesophageal sphincter pressure was measured as the difference between the sleeve pressure and the fundic pressure. Phasic contractions in the lower oesophageal sphincter, were considered to be present when resting pressure slowly but transiently increased to more than 50% of its basal value. In the 10 subjects in whom antral-duodenal, and jejunal motilities were monitored simultaneously with the oesophageal recording, the different phases of the migrating motor complex were visually identified according to accepted criteria.^{17,19} In these 10 subjects, it was determined whether the non-deglutitive pressure waves in the oesophageal body were temporally related to phase 3 of the migrating motor complex. This relation was accepted when the non-deglutitive pressure waves occurred in a time window of 15 minutes before the start of phase 3 in the antrum or proximal small bowel.

In the 15 subjects in whom antral and upper intestinal recordings were not available, the relation to phase 3 of the migrating motor complex could only be determined indirectly by the temporal relation of non-deglutitive pressure waves in the oesophageal body with the non-deglutitive phasic contractions of the lower oesophageal sphincter (this represented the sphincteric component of phase 3 of the migrating motor complex that occurred during the 10–15 minute period preceding phase 3 in the antrum or proximal jejunum, as shown previously by others.²) Student's *t* test for paired data was used for statistical analysis. Results are presented as means (SD).

Results

The total recording time analysed in the 25 subjects was 172 hours. In each subject a minimum of six hours of recording was analysed. The mean deglutitive activity consisted of peristaltic pressure waves in 76.7 (SD 21.2)% of the dry swallows. The pressure waves had a mean amplitude of 64 (37) mm Hg in the distal oesophagus (mean value for 5, 10, and 15 cm above the lower oesophageal sphincter, and a duration of 3.1 (1.0) seconds. The mean progression velocity was 3.9 (1.4) cm/s. The mean resting pressure in the lower oesophageal sphincter during the first 30 minutes of the recording was 17.6 (6.3) mm Hg.

Non-deglutitive activity was found in the oesophageal body of 24 of the 25 normal subjects

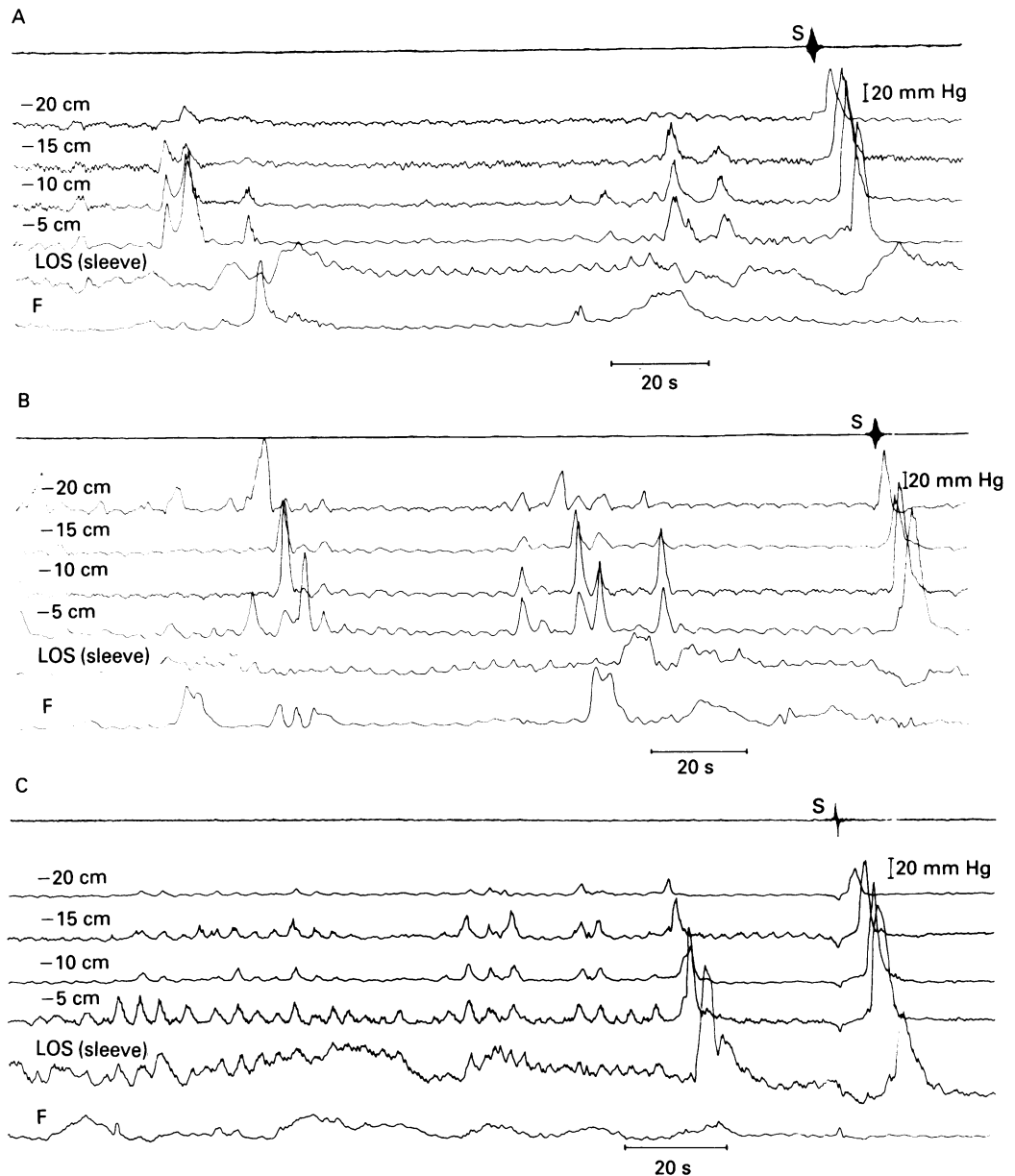
(Figure). This consisted characteristically of bursts of repetitive non-sequential pressure peaks with a mean of 2.7 (2) waves per burst (range two to 13). A burst was defined as a group of two or more contractions separated from preceding and following contractions by a short silent period of at least 10 seconds. A total number of 242 bursts (654 waves) were recorded during 172 hours of recording. The pressure waves during the bursts had an amplitude of 19.5 (9.9) mm Hg and a duration of 3.09 (0.22) seconds. This amplitude, but not the duration, was significantly lower than the corresponding value for peristaltic contractions induced by dry swallows ($p < 0.001$). The highest amplitude was 80 mm Hg recorded at 5 cm above the lower oesophageal sphincter. The longest burst consisted of 13 repetitive waves. The bursts were recorded in the lower oesophagus, up to a distance of 15 cm (70% of the bursts) and even 20 cm (40% of the bursts) above the lower oesophageal sphincter. They usually occurred in clusters of two to five bursts over a six to 15 minute period; 98% of the bursts occurred together with non-deglutitive phasic contractions of the lower oesophageal sphincter. In the 10 subjects in whom the gastrojejunal migrating motor complex was monitored on the oesophageal pressure days, 95% of the bursts occurred in the 15 minute time window before phase 3 of the migrating motor complex in the antrum or proximal intestine. The bursts of repetitive, non-sequential pressure peaks were often interrupted by peristaltic contraction waves, which could be deglutitive or non-deglutitive in nature.

The bursts of oesophageal contractions were not related to inappropriate lower oesophageal sphincter relaxations. In fact, none of the inappropriate relaxations of the lower oesophageal sphincter was accompanied by this type of non-deglutitive motor activity. These bursts of repetitive non-sequential pressure peaks did not show any characteristics that would suggest a common cavity phenomenon; they were not preceded by a sudden small increase in base line oesophageal pressure occurring simultaneously at different levels of the oesophagus; and the shape of the individual waves, although occurring simultaneously at different levels of the oesophagus, was often different from one level to the other.

The bursts were more often present during periods of low swallowing rate (for example, sleep): the mean swallowing frequency during the period of non-deglutitive motor activity was 0.51 (0.29) swallows/min, which was significantly lower than the 0.99 (0.26)/min swallowing rate during the remainder of the recording period ($p < 0.005$).

Discussion

It is generally believed that the normal oesophagus is only active in response to a stimulus (deglutition or oesophageal distension resulting in primary or secondary peristalsis) and that non-deglutitive activity of the oesophageal body is mostly abnormal. Also, the normal deglutitive response is generally considered to consist of a contraction wave that appears at manometry as a



Manometric recording in the gastric fundus (F), at four levels in the oesophageal body monitored with a sleeve device at 20, 15, 10, and 5 cm above the lower oesophageal sphincter (LOS) and in the LOS. Three different examples were recorded in three different normal volunteers. (A) Two bursts of non-deglutitive contractions composed of two to three simultaneous contractions. Most contractions have an amplitude that is considerably lower than that of the normal primary peristaltic contraction induced by swallowing (s). (B) Two bursts of up to five non-deglutitive contractions that appear simultaneously or in an uncoordinated manner. Their amplitude is of the same order of magnitude as the primary peristaltic wave induced by swallowing (s). (C) Another example of non-deglutitive activity consisting of bursts of several repetitive non-peristaltic contractions of low amplitude. The bursts occur together with phasic contractions in the LOS and end with the occurrence of a secondary peristaltic contraction. The last pressure complex represents the primary peristaltic contraction induced by swallowing (s).

single or M shaped peak. Repetitive waves – namely, two or more separate peaks in response to a single swallow are also generally believed to be abnormal.²⁰

This study shows that the motor activity of the normal human oesophagus is not limited to contraction waves in response to swallowing, but that non-deglutitive motility patterns occur in almost all normal gullets. The most striking non-deglutitive motility pattern we found in this group of normal subjects consisted of repetitive bursts of non-sequential pressure peaks in the smooth muscle of the oesophagus. These repetitive simultaneous pressure waves usually occurred together with the lower oesophageal sphincter component of the migrating motor complex. Our findings confirm and extend previous reports on the occasional occurrence of

single or repetitive pressure waves unrelated to swallowing during phases 2 and 3 of the gastroduodenal migrating motor complex.^{1,2}

The non-deglutitive motility pattern usually occurred when the subject was lying down quietly and relaxed and was swallowing infrequently. It may well be the reason why this motility pattern has previously attracted so little attention. During conventional manometric studies of oesophageal motility, the patient is asked to swallow at regular intervals to record deglutitive responses in the lower oesophageal sphincter and oesophageal body. This situation is different from the condition in which the present studies were performed and in which pressures were recorded over long periods, with the patient not being asked to swallow.

The clinical importance of the finding, there-

fore, lies in the interpretation of 24 hour pressure recordings in ambulatory patients. The circumstances in which part of these 24 hour studies are performed closely resemble the circumstances in which our studies were carried out. According to our data, non-deglutitive repetitive simultaneous pressure waves may occur as a normal oesophageal motor pattern. This has to be taken into account when determining reference values for 24 hour ambulatory manometry.^{3,21} These findings also have important implications for the analysis of prolonged motility recordings in patients with non-cardiac chest pain^{4,12}: repetitive simultaneous pressure waves occurring at the time of an attack of chest pain, do not necessarily indicate that the pain was accompanied by disorders of oesophageal motility, or that such disorders were the cause of the chest pain.

The present studies show that the migrating motor complex not only has a lower oesophageal sphincter component,² but also an oesophageal body component. As this oesophageal motor activity is non-peristaltic in nature, it probably does not have a function in clearing the oesophageal lumen from residual contents or refluxed materials.²² This is by contrast with phase 3 in the antrum and small intestine, which was shown to have a cleaning, 'housekeeper' function.^{18,23}

Although simultaneous oesophageal pH measurements were not done, the bursts of non-deglutitive contractions were not preceded by a small pressure plateau or other signs of a common cavity phenomenon.^{24,25} Therefore, it is unlikely that reflux of acid or gas had occurred just before the onset of the contractile activity. The bursts almost always occurred together with the lower oesophageal sphincter component of phase 3 of the migrating motor complex when the resting pressure in the sphincter is high.^{2,26} Moreover, transient lower oesophageal sphincter relaxations, which are a prerequisite for reflux to occur in the presence of a normal resting pressure of the sphincter,²⁷ were never seen before or during the non-deglutitive motor activity.

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