Dynamic esophageal scintigraphy in patients with achalasia

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Abstract

BACKGROUND: Dynamic esophageal scintigraphy has been proven as an efficient technique of diagnosis of esophageal dysmotility.
METHODS: The authors monitored the transit velocity, anti-peristalsis and the retention of radioactivity in the esophagus by dynamic esophageal scintigraphy in a group of 50 patients (37 control patients and 13 patients with achalasia).
RESULTS: They found a significantly longer period of radioactivity passage via the esophagus compared to the control group ($p < 0.001\%$).
CONCLUSIONS: We observed the statistically significant transit prolongation of radioactivity through the esophagus during dynamic esophageal scintigraphy (41.2 s) in our group of patients with achalasia compared to the control group (7.9 s). Anti-peristalsis and even the radioactivity retention have occurred statistically more frequently compared to the control group.
Key words: achalasia, esophageal scintigraphy, anti-peristalsis

Introduction

Diseases of the upper gastrointestinal tract occur very often. Whitaker (1) presented that in Great Britain about 8–10 percent of the patients who visit GPs suffer from gastrointestinal difficulties. However, it is impossible to determine any diagnosis by means of different examination methods for up to 50 percent of the patients. The diseases are usually called functional diseases, and one cause of their occurrence may be functional esophageal disorders.

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Motility disorders in the patients suffering from non-cardiac chest pains have been found in nearly 46 percent, and even a higher percentage has been found in the patients with dysphagia (1).

The spectrum of diagnostic methods for esophageal diseases is wide — from endoscopy, pH-metry, motilitometry, x-ray methods to radionuclide methods. We were interested in the changes that occur during dynamic esophageal scintigraphy in the patients suffering from achalasia.

Esophageal achalasia is the disease that removes esophageal peristalsis and increases LES pressure and it provides an incomplete relaxation as a reaction on deglutition.

Notes related to anatomy

Esophagus as a muscular pipe can be divided into three anatomical compartments — the upper esophageal sphincter (UES), the body and the lower esophageal sphincter (LES). All the compartments play a significant role in the following activities: food deglutition and transit, the cleaning of esophagus from regurgitated stomach content and the prevention of tracheobronchial aspiration (2).

Deglutition is divided into three phases. In the first phase, food is transported from the mouth to the pharynx by glossal pressure against the palate. In the second pharyngeal phase, the food is transported from the pharynx to the upper esophagus by reflex-coordinated contractures of the UES. In the third esophageal phase, the food is moved through the esophagus by both the coordinated peristalsis of esophageal muscles and the relaxation of the LES.

The food transit from the mouth to the proximal esophagus is related to the UES coordinated relaxation which results from the inhibition pulses of the masticatory centre via the nervus vagus. The UES tension may be changed by local factors, e.g. esophageal pH-value and its dilatation.

The esophageal body consists of the internal layer of circular musculature and the external longitudinal muscular layer. The proximal esophagus consists of striped musculature, distal esophagus from unstriped muscles and the central part consists of both striped and unstriped musculature. Voluntary deglutition starts by a peristaltic contracture that moves aborally with a speed of 3 cm/s. Many factors affect the speed of the contracture wave including the volume of swallowed bolus and its temperature. CNS controls peristalsis in the areas with striped musculature, and the areas with unstriped muscles are controlled by the central and peripheral areas. If any interval between two successive deglutitions is shorter than 10 s, many deglutitions are not followed by the peristaltic wave. The effect is called the deglutition inhibition (2).

The lower esophageal sphincter (LES) is the area which consists of unstriped musculature with a length of 3 cm and which separates the stomach from the esophagus. It prevents stomach reflux backwards into the esophagus, and provides a coordinated relaxation during deglutition and transit of bolus from the esophagus to the stomach. The lower esophageal sphincter (LES) is affected by myogenetic, neural and humoral stimuli.

Material and methods

The group consists of 13 patients (9 men and 4 women), with an average age of 50.9 (standard deviation of 17.0). The diagnosis of achalasia was made by esophageal manometry.

The standard values of food transit velocities quoted in references significantly differ from each other, and generally all authors stated that each workplace should elaborate its own standard methods. Hence, we worked out our own standard method.

The control group which was used to determine standard values was selected from the patients who were examined at least twice for motility and functional gastrointestinal tract disorders. In addition to dynamic esophageal scintigraphy, the patients were examined for gastric emptying. The negative anamnesis for esophageal diseases, the elimination of any organic finding in the upper gastrointestinal tract including negative gastrofibroscopy and standard biochemical findings (i.e. blood count, B.S.R., urine examination, AST, ALT, ALP, GMT, bilirubin, blood-urea and creatinine) are necessary for selection in the control group.

The group for the determination of standard MTT values consists of 37 persons, of these 25 women and 12 men, with an average age of 39.3 (standard deviation of 13.2). The patients were investigated by dynamic esophageal scintigraphy, and its evaluation was carried out by the method mentioned below.

At our department, dynamic esophageal scintigraphy was carried out in a lying position and with an empty stomach. 10 ml water with approx. 30 — 40 MBq 99m Tc SC was applied to the patients. The MB 9200 gamma camera monitors the radioactivity with a matrix of 64 x 64 points and a rate of 10 frames/s over 30 s. Then, the matrix of 128 x 128 points and 1 frame/s over 2 minutes was used (3, 4).

The evaluation was made with DIAG AT 486 unit (produced by Mediso, Hungary).

We estimate the period in which the radioactivity will penetrate in the stomach, i.e. the mean transfer time (MTT). Furthermore, we estimate anti-peristalsis in individual thirds of the esophagus, and we monitor that no radioactivity is captured in the individual areas. If the retention is evident, the patient must swallow and we monitor any reactions and the transfer of radioactivity.

Results

The average MTT value for our control group was 7.9 s (± 1.7 s). This result is very similar to the value of 7 s (± 3 s) that is quoted in references. Anti-peristalsis was only monitored occasionally, at one patient in the upper esophageal compartment, in the group of 4 patients in the central and lower esophageal compartments. When the Fisher-exact test for the anti-peristalsis statistical assessment was used in individual thirds of the esophagus, no significant difference of occurrence among the individual esophageal thirds has been found. The radioactivity retention has not been observed in any patients.

The individual MTT values in our group of the patients with achalasia are shown in Table 1. The average MTT value was 41.2 s (s.d. 42.8 s). This value is significantly higher if tested by the t-test (after the data transformation) at a 0.1 per mille significance.

With the exception of two patients, anti-peristalsis was found in the lower third of the esophagus in all cases; with the exception of three patients, all other cases exhibited anti-peristalsis in the middle third of the esophagus, and about half of the patients exhibited anti-peristalsis in the upper third of the esophagus (Table 1).

Table 1. MTT, anti-peristalsis and radioactivity retention in the patients suffering from esophageal achalasia

Patient	AGE	MTT	Anti-peristalsis (esophageal third)			Retention (esophageal third)		
	(years)	(sec.)	upper	middle	lower	upper	middle	lower
1	54	90	yes	yes	yes	no	no	no
2	75	10	no	no	yes	no	no	no
3	50	13	yes	yes	yes	no	no	no
4	_	120	yes	yes	yes	yes	no	no
5	35	20	yes	yes	yes	yes	no	no
6	60	6	no	yes	no	no	no	no
7	45	60	yes	yes	yes	yes	yes	no
8	68	7	no	yes	yes	no	no	no
9	49	11	no	no	yes	no	no	no
10	18	7	yes	yes	yes	no	no	no
11	65	12	yes	yes	yes	no	no	no
12	65	110	no	no	no	no	yes	no
13	54	70	yes	yes	yes	no	yes	no
Average	50.92	41.23	Σ= 8	Σ = 10	Σ = 11	Σ = 3	Σ = 3	Σ = 0
S.d.	17.74	43.87						
T-test		p< 0.00001						

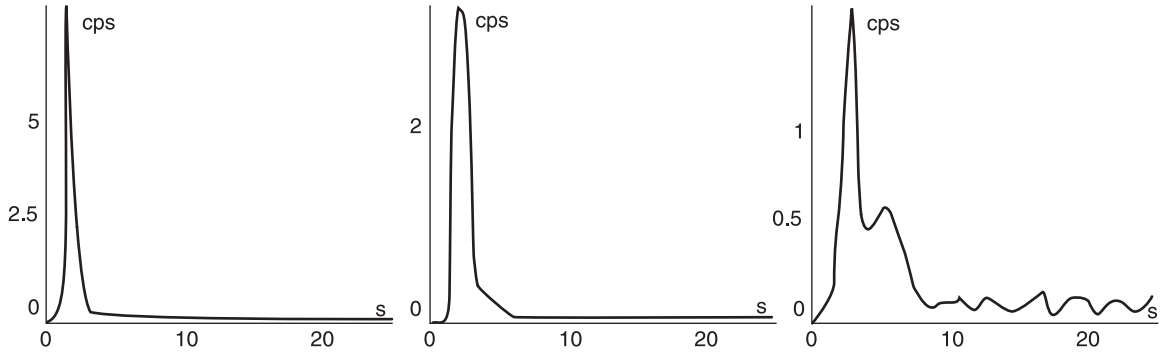

Figure 1. The normal curves of radioactivity *vs.* time above the upper, middle and lower esophageal parts.

(x-axis — time in seconds, y-axis — radioactivity in impulses/seconds)

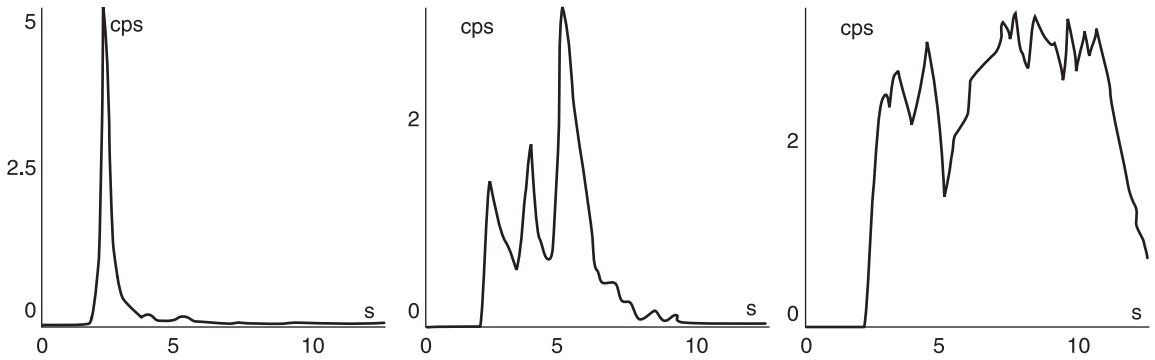

Figure 2. The curves of radioactivity *vs.* time above the upper, middle and lower esophageal parts — anti-peristalsis in the middle esophageal part.

(x-axis — time in seconds, y-axis — radioactivity in impulses/seconds)

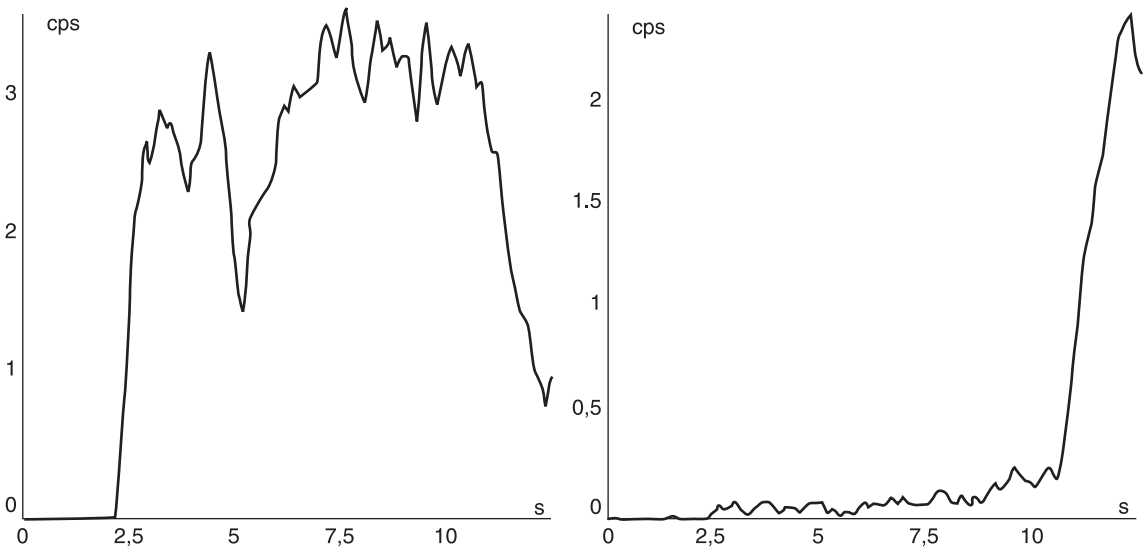

Figure 3. The curves of radioactivity *vs.* time above the lower esophageal part and above stomach — Anti-peristalsis in the lower esophageal part.

(x-axis — time in seconds, y-axis — radioactivity in impulses/seconds)

The radioactivity retention occurred in 3 patients in the upper third of the esophagus, in 3 patients in the middle part and no patients exhibited the radioactivity retention in the lower third of the esophagus (Table 1).

Neither the significantly frequent occurrence of anti-peristalsis, nor the radioactivity retention in any part of the esophagus were found by the Fisher-exact test. Both anti-peristalsis ($p < 0.0000$) and the radioactivity retention ($p < 0,00023$) were found with a statistically significant frequency compared to the control group.

Discussion

Dynamic esophageal scintigraphy (DES) is a simple method that monitors the transport of radioactive materials through the esophagus. Because of the low radiation burden, this method is convenient for the patients, and additionally it provides the exact quantification.

The use of radionuclides to monitor deglutition was described for the first time by Kazem (3). He conducted esophageal scintigraphy in a group of 12 volunteers and 20 patients suffering from tumorous esophageal obstruction. He applied in his study 20–40 MBq 99mTc pertechnetate in 10–20 ml tea/water that was swallowed by the patients in the upright position. Resulting from the radioactive curve analysis and serial pictures, he determined the radionuclide retention that corresponds to the magnitude of a mechanical obstruction in esophagus. He also proved an improvement after therapy, and he showed the possibilities of dynamic esophageal scintigraphy for the diagnostics of motility disorders.

Similarly as for many other diagnostic examinations, dynamic esophageal scintigraphy may be carried out in different ways. Different radionuclides, different methods of data acquisition, various labelled substances and different evaluation methods may be applied.

Achalasia is not a frequent disease, Kahrilas presented its occurrence of about 1 case per 100000 in the American population in a year (5), Richter presented a ten-times higher occurrence in Great Britain (6). Dysphagia, food regurgitation, chest pains, weight loss and aspiration pneumonia may occur during clinically manifested achalasia (7). However, the most frequent is chest pain, especially during the initial phases of the clinical manifestation. Simple x-ray pictures and contrast medium examinations can be used for the primary screening (8). Endoscopic examination can reveal tumorous affection, and it can provide biopsy sampling. Esophageal manometry is very important if x-ray pictures are negative or unclear (8). Kahrilas presented that the clear manometric finding is found for more than 90 percent of all patients (5).

Richter qualified the method of dynamic esophageal scintigraphy as a non-specific examination. He recommended that the method can be used for the monitoring of therapeutical effects and the disease course (6). The same conclusion was submitted by Maurer who presented that pressure measurement in the area of the lower esophageal sphincter is not sufficient to assess the therapeutic effect of achalasia (8). He also stated the highest sensitivity of dynamic esophageal scintigraphy for the primary esophageal motility disorders, e.g. achalasia, diffuse esophageal spasm and sclerodermia.

Even if the changes that were observed during dynamic esophageal scintigraphy are not specific, we can recommend that the method of evaluation is suitable in the case of achalasia. If x-ray pictures and manometric findings are evident, the method will not bring additional information. If not only the speed of transit through the esophagus, but also anti-peristalsis and the radioactivity retention are assessed in the individual thirds of the esophagus, the benefit of the above-mentioned examination in controversial cases is unquestionable.

Conclusions

We observed the statistically significant prolongation of esophageal transit time during dynamic esophageal scintigraphy (41.2 seconds) in our group of the patients suffering from achalasia compared to the control group (7.9 seconds). Anti-peristalsis and even the radioactivity retention have occurred statistically more frequently compared to the control group.

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