COMPARISON OF THE RESULTS OF INVESTIGATION OF INTESTINAL MOVEMENTS BY THE X-RAY AND WINDOW METHODS

M. M. Popov, P. V. Vlasov, and M. A. Kir'yakov

UDC 612.327+612.337]-08

Numerous investigations of the motor function of the gastro-intestinal tract have been made [1-3, 5-7, 9, 11-13], yet many aspects of this function are still incompletely studied.

To help to remedy this defect, we performed a series of experiments on rats and rabbits.

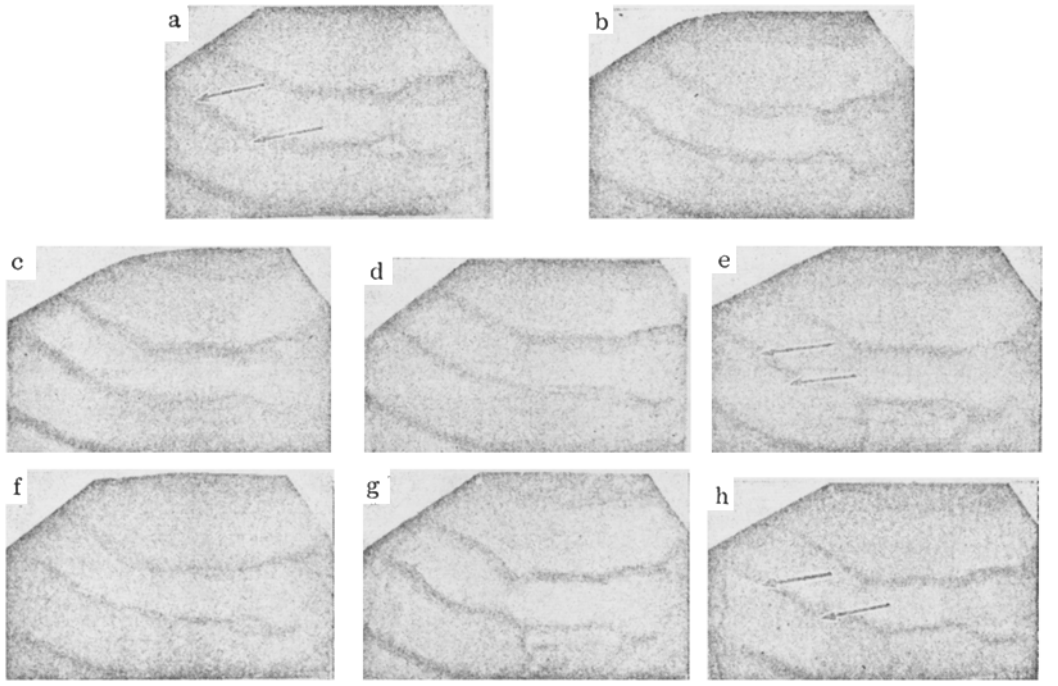

Fig. 1. Series of frames obtained during filming of a rat's intestine through a window in the abdominal wall. Filming speed 24 frames/sec. Prints made from every sixth frame. Pendulum-like movements of small intestine identified by changes in distances between vessels (indicated by arrows): a) maximal distance; b, c) 6th and 12th frames, distance apart reduced; d, e) 18th and 24th frames, least distance apart, just over half that in 1st frame; f, g) 30th and 36th frames. Phase of relaxation and longitudinal stretching of intestine. Distance apart gradually increased; h) 48th frame, distance between blood vessels back to its initial value shown on 1st frame. 1.5 ×.

Institute of Medical Radiology, Academy of Medical Sciences of the USSR, Obninsk (Presented by Active Member of the Academy of Medical Sciences of the USSR G. A. Zedgenidze). Translated from Byulleten' Éksperimental'noi Biologii i Meditsiny, Vol. 65, No. 4, pp. 122-124, April, 1968. Original article submitted June 15, 1966.

EXPERIMENTAL METHOD AND RESULTS

Twenty August and Wistar rats and 20 Chinchilla rabbits were studied.

The x-ray investigation was carried out by the methods of serial radiography, fluoroscopy with the use of an electron-optical intensifier, and x-ray cinematography.

The animals were fixed to special plywood or plexiglas panels. The contrast material was an aqueous suspension of barium, which was introduced through a tube inserted into the esophagus. The rabbits received about 100 ml of suspension each, and the rats about 3 ml each.

During the investigation we discovered that not all the intestinal movements described in the literature can be defined clearly enough roentgenologically. Because of this, a series of experiments was performed in which a window was formed in the anterior abdominal wall of the experimental animals by the method of Katsch and Borchers, in order that simultaneous observations could be made on movements of the intestinal wall through the window and on the x-ray picture of the behavior of the contrast material in the digestive tract. Accordingly, a transparent window of polyethylene film was sutured into the anterior abdominal wall of 12 rats and 5 rabbits.

Motion pictures were taken during the 2nd, and sometimes the 3rd, week after the operation.

By comparing the x-ray pictures of the intestinal movements with those observed through the window, it is clear that by means of the window method it was possible to see clearly the true pendulum-like movements visible only by direct observation on the intestine and not demonstrable roentgenologically.

Pendulum-like movements have been known for a long time. They were first described in 1858 by Ludwig as localized longitudinal contractions of the small intestine leading to displacement of neighboring areas to either side alternately. Later this term began to be used to describe various concepts. Many roentgenologists who have studied the contractile activity of the small intestine, mainly from changes in the shape and position of the contrast material mixed with the intestinal contents, have identified the oscillatory movements of the contrast material with the pendulum-like movements of the intestinal wall as described by Ludwig.

Our investigations showed that the oscillatory movements of the intestinal contents, as revealed by their roentgenologic appearance, are present as a rule throughout the length of the small intestine and in the cecum also.

No evidence was found for identifying these oscillatory movements of the intestinal contents revealed by x-ray examination with true pendulum-like movements of the intestinal wall.

The oscillatory movements are due either to rhythmic segmentation and tonic contractions of the circular muscle above and below the column of contrast material or to alternation of peristalsis and antiperistalsis.

By making observations on the digestive tract through the window sutured into the anterior abdominal wall, we found that the pendulum-like movements are weak longitudinal contractions of the intestinal wall of the greatest constancy. They were produced rhythmically: every 2 sec a contraction and relaxation of a localized area of the intestine commences. It can be seen in Fig. 1 that with a filming speed of 24 frames/sec, the contractions attain maximal development at the 24th frame. One second later (48th frame) the intestine is back in its initial state. In contrast to rhythmic segmentation, tonic contractions, and peristalsis, which have the function of coarse mechanical treatment and mixing of the food, the pendulum-like movements have a different purpose. In the light of new ideas concerning contact digestion [4], it seems probable that in the small intestine they are of great importance in the enzymic digestion and absorption of food substances by the intestinal wall, bringing it into contact with fresh microparticles of chyme from time to time as a result of its visible undulation.

The window method is thus a valuable means of studying movements of the digestive tract.

LITERATURE CITED

1. V. N. Smotrov, Chronic Colitis [in Russian], Moscow-Leningrad (1934).
2. A. M. Ugolev, Digestion and Its Adaptive Evolution [in Russian], Moscow (1961).
3. I. A. Shekhter, Zdravookhr. Kazakhstana, No. 5-6, 20 (1945).

4. B. M. Shtern, Roentgonologic Observations on the Morphology and Functions of the Small Intestine [in Russian], Leningrad (1939).
5. W. C. Alvarez, The Mechanics of the Digestive Tract, New York (1929).
6. W. M. Bayliss and E. H. Starling, J. Physiol. (Lond.), 26, 127 (1910).
7. W. B. Cannon, The Mechanical Factors of Digestion, London (1911).
8. G. Katsch and E. Borchers, Z. Exp. Path. Ther., 12, 225 (1912/1913).
10. C. Ludwig, Lehrbuch der Physiologie des Menschen, Leipzig (1958).
11. R. Magnus, Pflüg. Arch. Ges. Physiol., 103, 515 (1904).
12. F. Schneller, Pflüg. Arch. Ges. Physiol., 209, 117 (1925).
13. P. Trendelenburg, Arch. Exp. Path. Pharmak., 81, 53 (1917).