Solid phase radionuclide esophageal transit in mixed connective tissue disease

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Abstract
Esophageal motility was studied in 24 patients with mixed connective tissue disease (MCTD) and 20 control subjects by the solid phase radionuclide esophageal transit study. A computer routine modified from Klein and Russel was used. Total mean transit time, regional mean transit time, residual fraction after first swallow, and retrograde index increased significantly in MCTD patients compared with normal control subjects. An abnormal total mean transit time occurred in 84% (20 of 24) of the patients with MCTD. Our results confirmed that delayed esophageal transit is common in patients with MCTD.

Key words: Mixed connective tissue disease—Solid phase—Esophageal transit study.

Some patients have features suggesting more than one rheumatic disease. Patients with a combination of clinical findings similar to those of systemic lupus erythematosus, progressive systemic sclerosis, and dermatopolymyositis/polymyositis, with unusually high titers of circulating antinuclear antibody with specificity for a nuclear ribonucleoprotein antigen, are considered to have mixed connective tissue disease (MCTD) [1]. MCTD occurs in patients aged 4–80 years, with a mean of 37 years; approximately 80% are female. The typical clinical features of MCTD are polyarthritis, Raynaud’s phenomenon, swollen hands or sclerodactyly, pulmonary disease, inflammatory myositis, and esophageal hypomotility. Esophageal dysfunction has been reported in up to 70% of patients with MCTD [2]. As yet, only a few manometric studies have been performed in MCTD and the results are not concordant [3–6].

For the recognition and characterization of esophageal motor disorders, manometry using multiple intraluminal pressure sensors is the most reliable tool. However, manometric investigations can be carried out only in specialized laboratories and require considerable experience and expertise. A more serious limitation is that they do not provide information on the transport of a bolus through the esophagus. The transport can be quantitated by radionuclide techniques. This method was originally described in 1981 by Russel et al. [7]. This investigation is easy and quick to perform, does not require dedicated apparatus, and produces only a small radiation burden for the patient. In this study, we used a solid phase radionuclide esophageal transit study to evaluate the esophageal motility of patients with MCTD.

Materials and methods
The study population consisted of patients with MCTD under the continuing care of the Division of Rheumatology at our hospital. The diagnosis of MCTD was made according to the overlapping clinical features of at least two diseases among progressive systemic sclerosis, systemic lupus erythematosus, and dermatopolymyositis/polymyositis, associated with a high titer of anti–nuclear ribonucleoprotein antibody [8]. Twenty-four patients were studied: 22 women and two men, with an age range of 17–68 years. In addition, 20 normal volunteers (eight men and 12 women; age range = 25–65 years) were included in the study. With the subjects lying supine, posterior imaging from the chin level downward was performed with a scintillation camera. Two Tc-99m-pertechnetate sources marked the cricoid cartilage. Data were acquired in the list mode for 2 min after an oral dose.
of a 4-mL bolus of solid gelatin (0.4 g commercial gelatin + 4 mL water; density = 1.0 g/cm³) containing 1 mCi of Tc-99m phytate. The Tc-99m phytate had been dissolved in a heated solution of gelatin and water, which was then refrigerated until solidified in a teaspoon. After the patient took a sip of water (as a lubricant), the bolus was swallowed in one single swallow together with 15 mL of water. No mastication was allowed before swallowing so that the bolus had a fixed geometry during its transit, and no spontaneous swallowing was allowed during the 30 s before each test [9].

The data processing method was modified from that of Kelin and Wald [10]. After changing the format from the list mode data to 4 frames/s, the first 64 frames were summed and displayed in the left upper quadrant of the television monitor. The area of the esophagus could be visualized easily from the summation image in the left upper quadrant. Four movable horizontal lines were then generated by the computer and positioned by the operator to select the range of the esophagus. Because the esophagus is a tubelike structure, the frame could be transformed into a vertical line without loss of useful information by replacing each row of the frame with its integration. The condensed image in the upper right quadrant (Fig. 1) was created by arranging the transformed lines in time sequence, so that the spatial distribution of the radioactivity was shown on the y axis, and the temporal information was shown on the x axis. The flow of radionuclide through the esophagus could be described by a centroid curve that plotted the center of the mass of the spatial distribution of radioactivity versus time. Under normal conditions, the centroid curve should go downward from left to right. The retrograde index was defined as the ratio of the greatest upward difference in the centroid curves to the length of the esophagus (Fig. 2A). The time activity curves of the proximal, middle, distal, and total esophagus and the stomach were generated from the condensed image. The mean transit time (MTT) was generated from the time activity curves by the following area-over-height formula [10]:

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MTT = \frac{\int_0^T M(t) \, dt}{M_{\text{max}}}
\]

where the numerator is the area under the curve and the denominator is the height of the curve. The residual fraction was defined as the ratio of the residual minimum activity to the peak activity of the total esophageal time activity curve (Fig. 2B). Student’s t test was used to test statistical significance.

**Results**

The results are summarized in Table 1. The total mean transit time, regional mean transit time, residual fraction