

ESOPHAGEAL MOTILITY: AN ICONOGRAPHIC ESSAY ON DYNAMIC ESOPHAGEAL SCINTIGRAPHY*

Maria Expósito Penas¹

Abstract This study is an interesting selection of esophageal dynamic images and respective activity/time curves to demonstrate motility ranging from normal to the opposite extreme (advanced-stage achalasia). The technique employed was: 4-hour fast, with restriction of smoking, alcohol and caffeine products; anterior 0.5-second imaging during 2 minutes, covering the region from the mouth to the gastric fundus, followed by a planar 20-second image from the same region (normal transit time: < 10 seconds). The collection is based on a twenty-year experience employing a systematization including several parameters, which is able to discriminate patients with normal total esophageal transit time independently of symptoms.

Keywords: Esophageal scintigraphy; Transit time; Motility; Achalasia; Parameters.

Resumo *Motilidade esofágica: ensaio iconográfico sobre cintilografia dinâmica do esôfago.*

Este trabalho é uma seleção interessante de imagens dinâmicas do esôfago e de curvas de atividade/tempo, variando da motilidade normal até o extremo oposto, a acalásia em estado avançado. A técnica é a usual: quatro horas de jejum, com restrição de fumo, álcool e cafeína; incidência anterior; imagens de 0,5 segundo durante dois minutos, região da boca ao fundo gástrico, seguida de imagem plana de 20 segundos da mesma região (tempo de trânsito normal: < 10 segundos). A coletânea é baseada em vinte anos de experiência empregando uma sistematização com vários parâmetros de análise que permite discriminar pacientes com tempo total de trânsito normal.

Unitermos: Cintilografia esofágica; Tempo de trânsito; Motilidade; Acalásia; Parâmetros.

INTRODUCTION

The present essay is aimed at showing an interesting selection of images and graphics demonstrating esophageal motility in a spectrum ranging from normal to the opposite extreme that is an advanced-stage achalasia. Besides studies utilizing room-temperature water for radiotracer dilution, further studies (Bernstein tests) were performed with volunteers (with free and informed consent) utilizing mild hydrochloric acid (at 0.1 N and 0.05 N concentration) to reproduce symptoms of gastroesophageal reflux. All of the studies were approached by a standard systematization including the following parameters (for normal values [n]): total esophageal transit time (TETT) (n: < 10.0 s), curve pattern (CP) (n: coordinated), residual activity (RA) (n: < 10%), time for initial entry

into stomach (TIES) (n: < 6.0 s), stomach entry form (SEF) (n: abrupt), retrograde movements (RM) (n: absent), curve variation factor (CVF) (n: < 0.1), transit time in the proximal, middle and distal esophageal thirds (PTT, MTT, DTT) (respectively n: < 3.0 s, < 6.0 s and < 10.0 s) and a plain radiographic image of the esophagus (PRI) at the end of the dynamic scintigraphy (n: absent or mild residue)⁽¹⁻³⁾.

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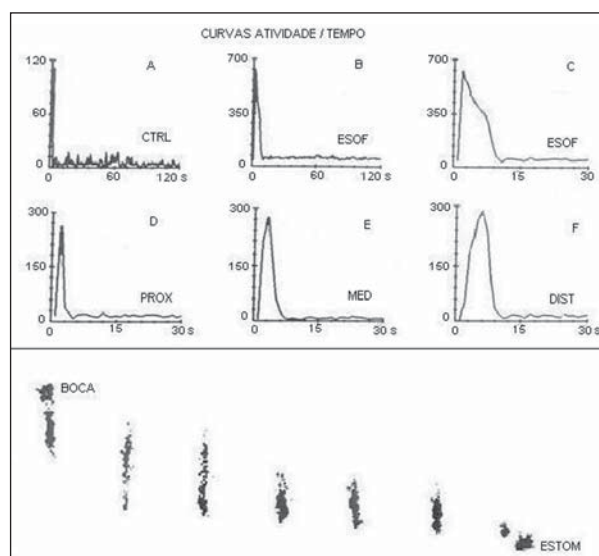
* Study developed in the Department of Radiology – Nuclear Medicine at Faculty of Medicine, Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brazil.

1. PhD, Associate Professor, Department of Radiology – Nuclear Medicine at Faculty of Medicine, Universidade Federal do Rio de Janeiro (UFRJ), Rio de Janeiro, RJ, Brazil.

Mailing address: Profa. Dra. Maria Expósito Penas. Rua Alfredo Corrêa, 150, ap. 204, Ilha do Governador. Rio de Janeiro, RJ, Brazil, 21920-225. E-mail: exposito@hucff.ufrj.br

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Figure 1. Normal study. Male, 37-year-old volunteer with no esophageal or general complaint. **A:** Activity/time curves of the control area of interest demonstrating a single swallowing. **B,C:** Stomach curve in 120 s and detail in 30 s. **D,E,F:** Curves corresponding to the three esophageal thirds. Normal parameters (TETT: 8 s; TIES: 4 s; SEF: single; RA: < 10%; RM: absent; CP: coordinated; CVF: 0.07; PRI: negligible residual activity). Also, normal dynamic 0.5 s images. Study suggesting absent esophageal motor disorder.



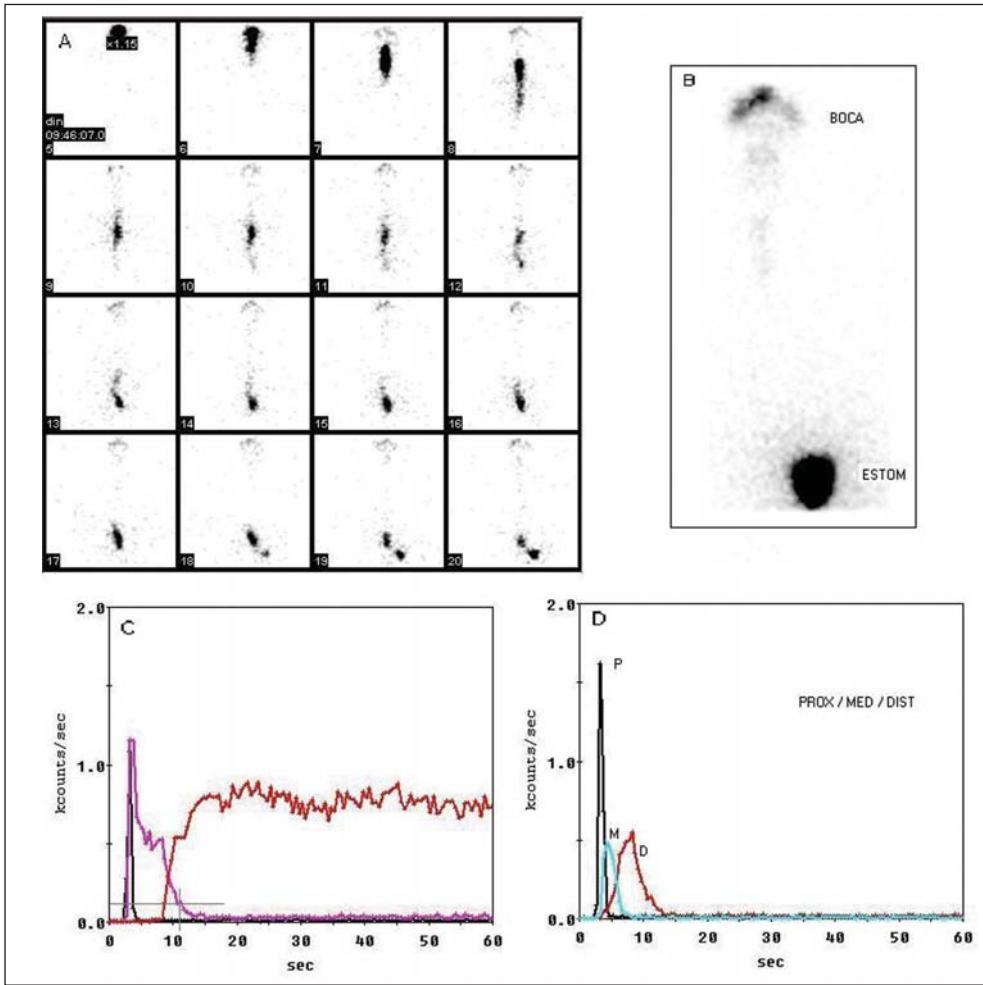


Figure 2. Female, 40-year-old patient with dysphagia. Normal plain radiographic image of the esophagus. **A:** Sequential dynamic images with a normal aspect. **B:** PRI with a negligible residual activity at the proximal esophagus level. **C:** Esophageal curve with a slight uncoordinated notch corresponding with a notch on the stomach entry curve (stepped); control area curve demonstrating a single swallowing. **D:** Curves corresponding to the three esophageal thirds with a coordinated pattern and normal timing. Parameters: TETT: 9.5 s; TIES: 7 s; SEF: stepped; RA: normal; RM: absent; CP: slight, uncoordinated; CVF: 0.08; PRI: normal. The TETT and the CVF indicate this study as normal; however, TIES, SEF and CP are altered.

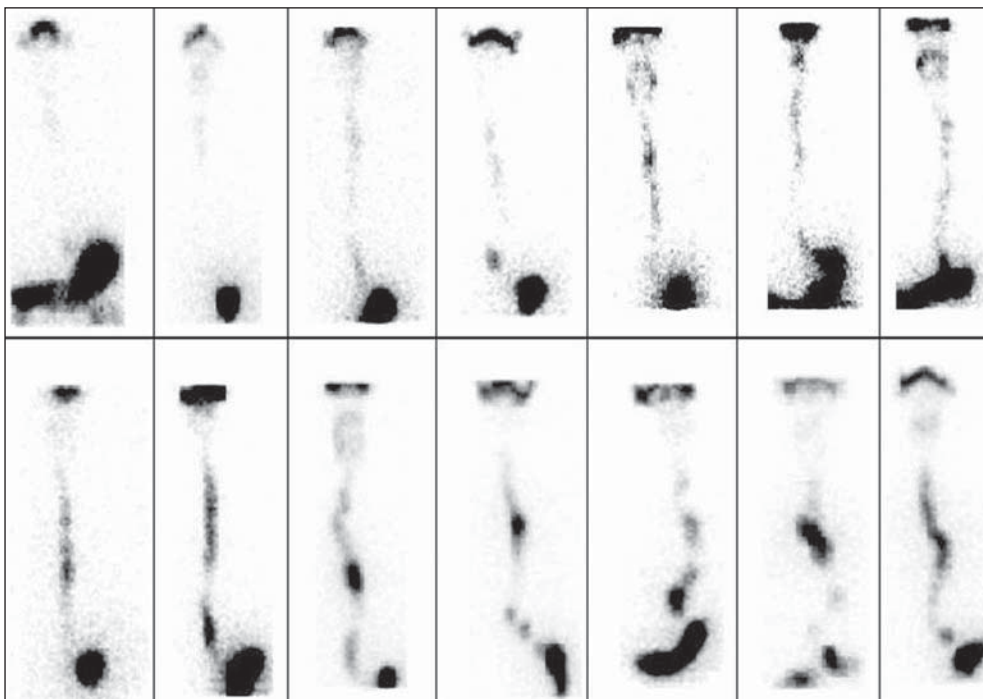


Figure 3. Plain radiographic images of esophagus at the end of the dynamic scintigraphy. The sequence is initiated with normal images (1 and 2), linear route, with no or only discrete residual activity, not suggesting an increase in the esophageal caliber. The following images indicate a focal or diffuse increase in the residual activity, with a linear route that gradually becomes tortuous suggesting, in some images, an increase in the esophageal caliber. In this Figure, the image of achalasia is not included (see Figure 7, where an increase in caliber can be more clearly identified). In some cases, a significant esophageal narrowing may be observed in the distal esophageal third, which is usual in more advanced stages of the disease.

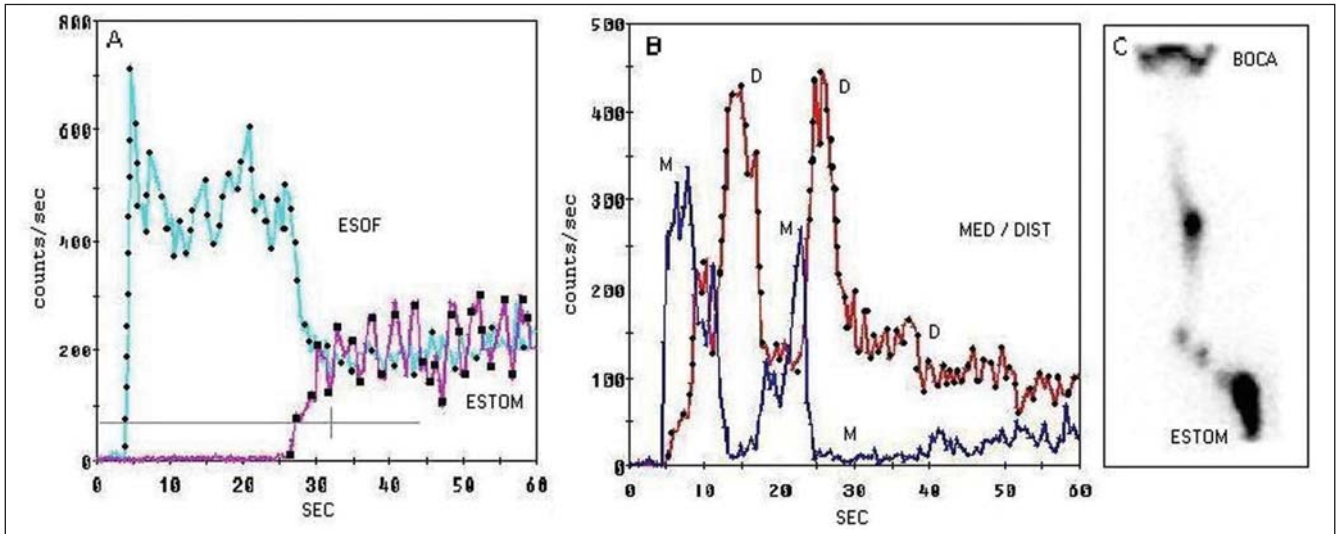


Figure 4. Female, 38-year-old patient with dysphagia and heartburn, without diabetes or connective tissue disease. Esophagus/stomach curve (A) and curves corresponding to the middle and distal esophageal thirds (B) showing antegrade and retrograde movements. C: PRI demonstrating a dilated and tortuous image of the esophagus, with a significant residual activity at the level of the middle-proximal third and subtle foci in the distal esophageal third. Significant esophageal motor dysfunction. All the parameters are altered, with the exception of transit time in the proximal esophageal third (not shown). Significant esophageal motility disorder.

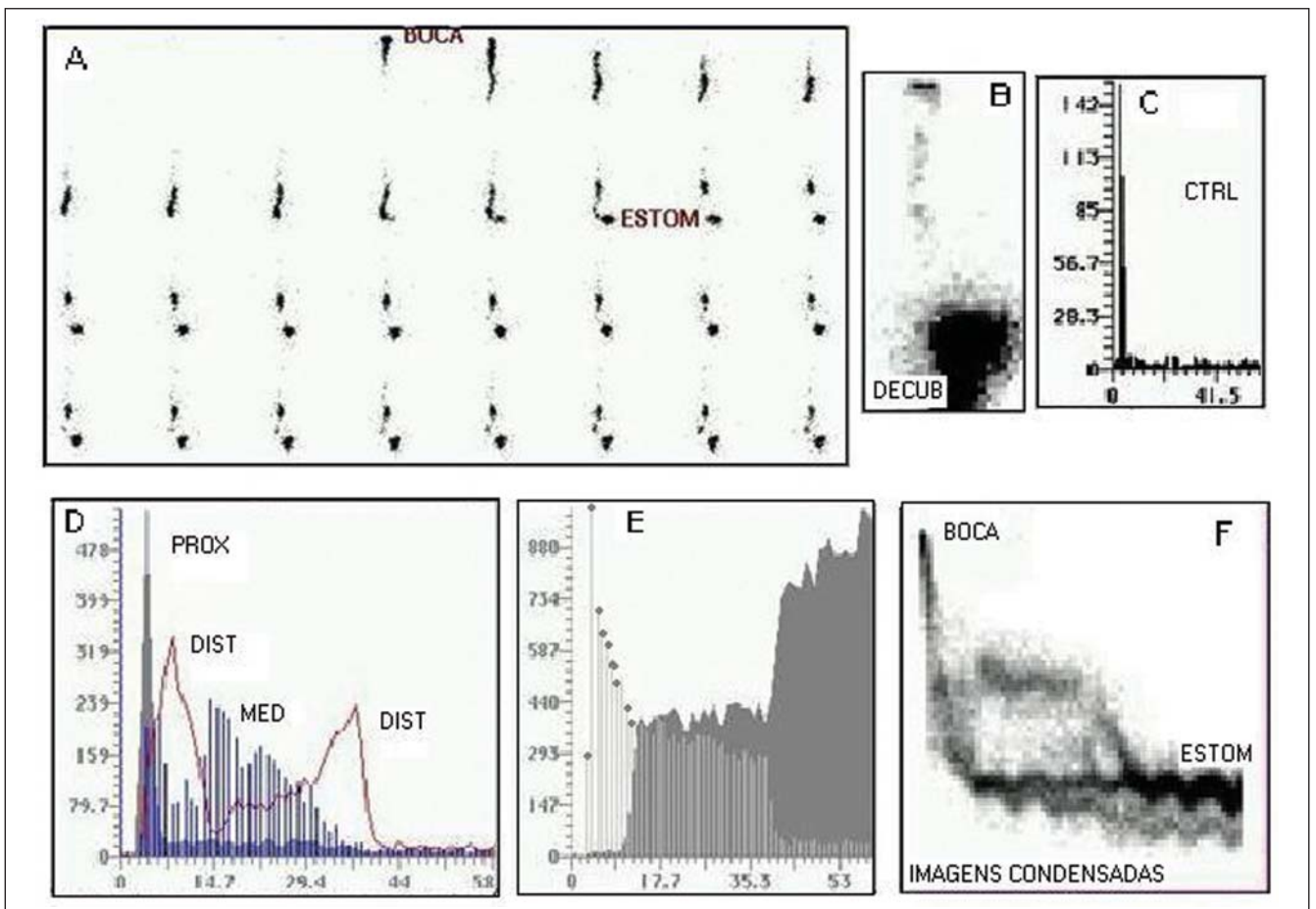


Figure 5. Female, 51-year-old patient with dysphagia and diagnosis of scleroderma, without diabetes. Manometry demonstrating adynamia of the esophageal body. A: Dynamic images showing a tortuous route. B: PRI demonstrating diffuse residual activity in the proximal and middle esophagus. C: Control curve demonstrating a single swallowing. D: Curve demonstrating overlapping of esophageal thirds, where the bolus reflux from the distal to the middle esophagus is clear, likewise in the dynamic images. E: Esophagus/stomach curve demonstrating stepped entry into stomach. F: Curve corresponding to condensed images clearly demonstrates the temporary radioactive bolus retention in the middle esophagus. Significant esophageal motor dysfunction.

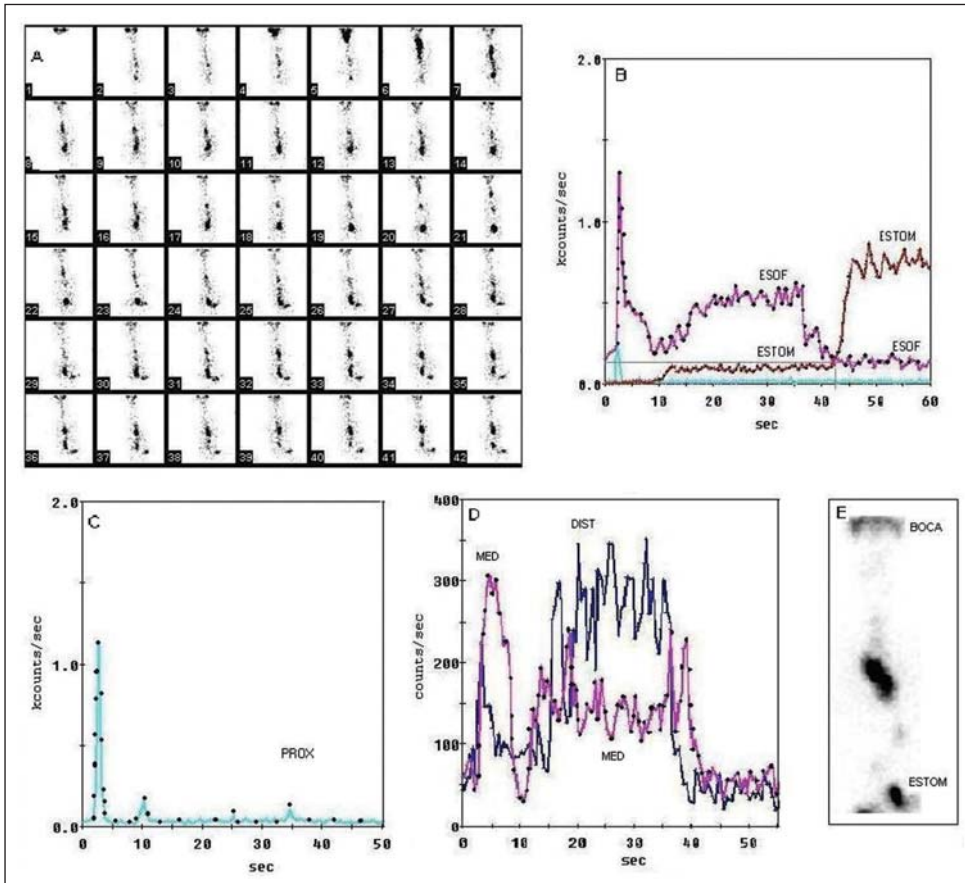


Figure 6. Female, 46-year-old patient with dysphagia and chest pain, without diabetes or connective tissue disease. Manometry demonstrating low amplitude waves in the esophageal body. Normal stress test and myocardial perfusion scintigraphy. **A:** Dynamic images demonstrate retrograde movements. **B:** Esophagus/stomach curve (TETT: 40 s; TIES: 16 s, with a small amount of the radioactive bolus entering into the esophagus; SEF: stepped; RA: 10%; RM: present, identifiable at dynamic scintigraphy and esophageal thirds curves; obviously increased CVF). **C:** Proximal esophageal third curve – normal transit time; radiotracer reflux is observed up to this level (two lower peaks). **D:** Increased transit times in the middle and distal esophagus and retrograde movements. Significant esophageal motor dysfunction, with all of the parameters with alterations, with the exception of the transit time in the proximal esophagus. **E:** Plain radiographic image of esophagus demonstrating intense focal increase in residual activity in the middle esophageal third.

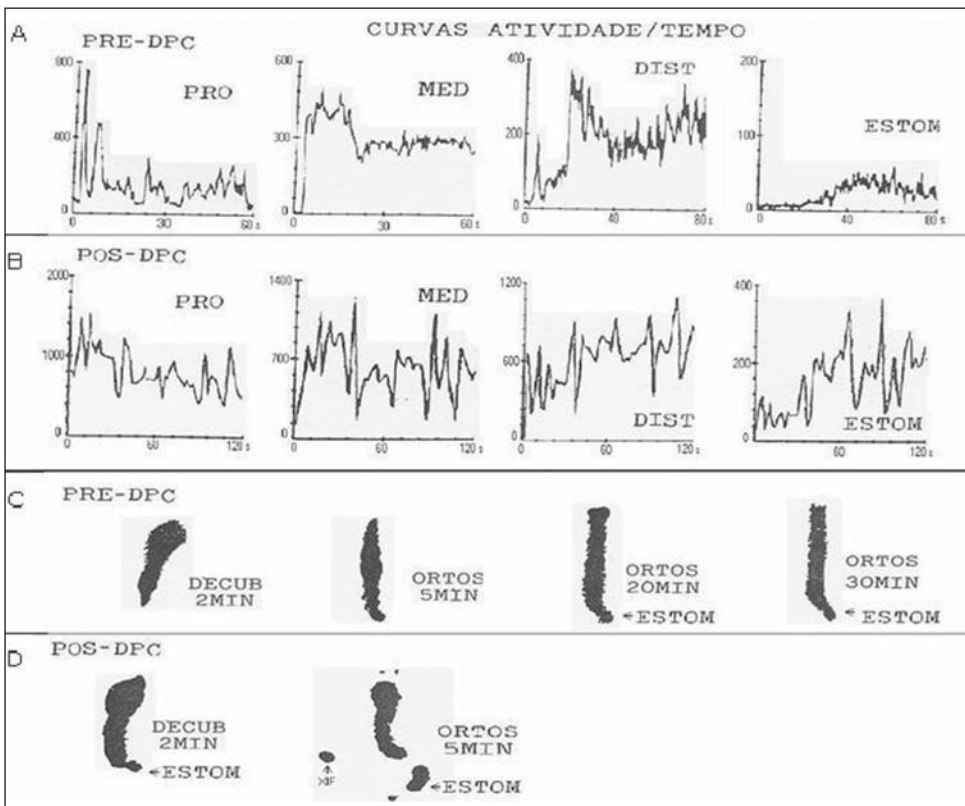


Figure 7. Female, 48-year-old patients with dysphagia and chest pain. Endoscopy suggesting achalasia and positive Bernstein test. **A:** Pre-pneumatic dilatation (PD) phase of the cardia – curves of the proximal, middle and distal esophageal thirds and stomach, all of them with an abnormal aspect. **B:** The same sequence of curves in the post-PD phase. **C:** Esophageal images at the end of the dynamic study where an increase in the caliber of the proximal and middle esophagus is observed, without a clear identification of the distal esophagus. The following three images acquired in orthostatic position demonstrate the distal esophagus and a subtle image of the stomach corresponding to the radioactive bolus with 10 ml of water that remained in the stomach for more than 30 minutes. **D:** Post-PD phase. Image acquired at the end of the dynamic study with a subtle contour of the stomach, a little more evident in the orthostatic position, but still with an intense radiotracer presence in the esophagus. Study typically demonstrating achalasia in the pre-PD phase, evidencing the low efficacy of the PD, in spite of the improvement of the symptoms reported by the patient. This study corroborates the sensitivity of the method.

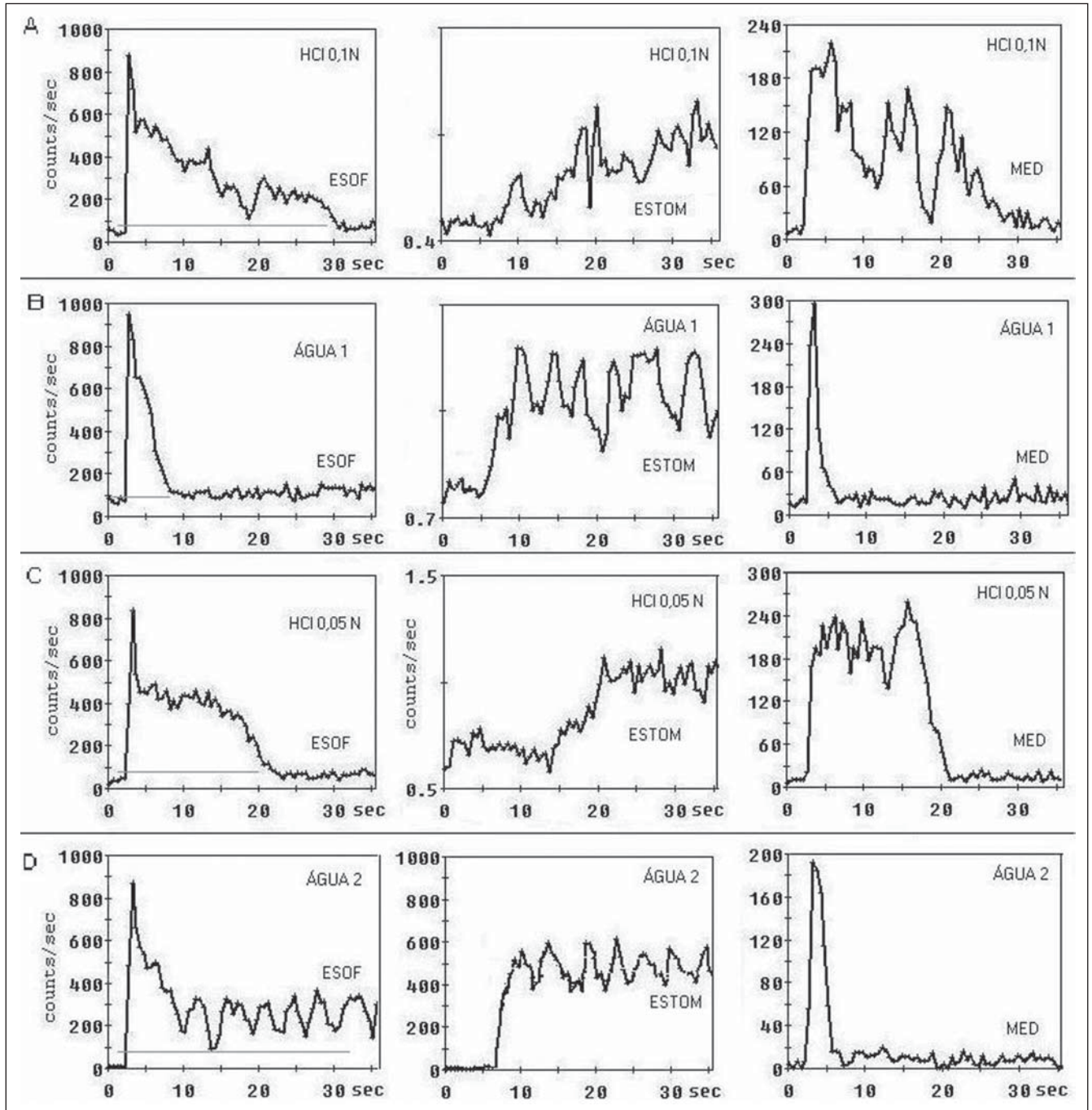


Figure 8. Studies performed in the following sequence: basal study (not shown) (TETT: 7 s, TIES: 4 s, SEF: single, RA: < 10%, RM: absent). **A:** First study with 0.1 N HCl (TETT: 29 s, TIES: 3 s, SEF: progressive, RA: 10%, RM: present). **B:** Repeated study with water as diluent (TETT: 7 s, TIES: 6 s, SEF: stepped, RA: > 10%, RM: absent). **C:** Study with HCl 0.05 N (TETT: 20 s, TIES: 11 s, SEF: stepped, RA: < 10%, RM: present). **D:** Repetition of the study with water (TETT: 8 s, TIES: 5 s, SEF: single, RA: 25%, RM: absent). Observe, in the middle third curves, the presence and absence of retrograde movements, depending on the diluent utilized. It is interesting to observe the difference between responses to both HCl concentrations and the return to normal, except for the RA in the last study. This seems to open the way for new researches: which would be the response to other types of diluent? Could they improve the diagnosis? Which would be the response to therapeutic drugs? These curves corroborate the concept that the method is simple, highly physiological, reproducible and reliable, in a single swallowing.