

# Comparison of Gastric Wall Thicknesses with Hydrogastric Sonography in Functional Dyspepsia Patients

## Fonksiyonel Dispepsi Hastalarında Hidrosonografi ile Mide Duvar Kalınlıklarının Karşılaştırılması

Murat AKFIRAT, MD,<sup>a</sup>  
Hüseyin Ayhan KAYAOĞLU, MD,<sup>b</sup>  
Namık ÖZKAN, MD,<sup>b</sup>  
Ömer Faik ERSOY, MD,<sup>b</sup>  
Alper ÇELİK, MD,<sup>b</sup>  
Selçuk Mevlüt HAZİNEDAROĞLU, MD<sup>c</sup>

Departments of

<sup>a</sup>Radiology,

<sup>b</sup>General Surgery,

Gaziosmanpaşa University

Faculty of Medicine, Tokat

<sup>c</sup>Department of General Surgery,

Ankara University Faculty of Medicine,

Ankara

Geliş Tarihi/Received: 19.11.2008

Kabul Tarihi/Accepted: 28.08.2009

Yazışma Adresi/Correspondence:

Namık ÖZKAN, MD

Gaziosmanpaşa University

Faculty of Medicine,

Department of General Surgery, Tokat,

TÜRKİYE/TURKEY

namikozkan@yahoo.com

**ABSTRACT Objective:** Because the etiology and pathophysiology of the functional dyspepsia remains unclear, the optimal management is still controversial. This study was aimed to determine the actual gastric wall thicknesses in the subgroups of functional dyspepsia patients, and to investigate whether there was any correlation with the symptoms. **Material and Methods:** Functional dyspepsia patients (n= 136) were divided into six groups in regard to the predominant symptom; as group 2: epigastric discomfort; group 3: epigastric pain; group 4: nausea; group 5: vomiting; group 6: bloating and group 7: early satiety. Control group was selected from the patients who underwent ultrasonographic examination for gynecologic or urinary reasons and had no gastrointestinal symptoms (group 1). The patients were investigated by hydrogastric sonography following conventional trans-abdominal sonography. Same independent radiologist blind to the symptoms, measured the thicknesses of anterior and posterior gastric walls in fundus, corpus and antrum. **Results:** Anterior and posterior fundus walls were detected as significantly thickened in groups 2 and 7 (p< 0.05). Both the anterior and the posterior walls of the corpus and antrum were found significantly thicker than the other groups in the group 3 (p< 0.05). **Conclusion:** This study documented significant gastric wall thickness differences between the subgroups of the functional dyspepsia patients.

**Key Words:** Dyspepsia; gastrointestinal diseases; ultrasonography; stomach diseases

**ÖZET Amaç:** Fonksiyonel dispepsinin etiolojisi ve patofizyolojisi açık olmadığından optimal tedavisi de halen tartışmalıdır. Bu çalışmada fonksiyonel dispepsili hastaların alt gruplarında mide duvar kalınlığının tespit edilerek semptomla göre farklılık olup olmadığı araştırılması amaçlanmıştır. **Gereç ve Yöntemler:** Fonksiyonel dispepsi hastaları (n= 136) baskın olan semptomla göre altı gruba ayrıldı; grup 2: epigastrik rahatsızlık; grup 3: epigastrik ağrı; grup 4: bulantı; grup 5: kusma; grup 6: şişkinlik ve grup 7: erken doyma. Kontrol grubu ise jinekolojik veya üriner nedenlerle ultrasonografik inceleme gerektiren ve hiçbir gastrointestinal semptomu olmayan hastalardan oluşturuldu (grup 1). Hastalar konvansiyonel abdominal ultrasonografiyi takiben hidrosonografi ile değerlendirildi. Semptomlardan habersiz bir radyolog tarafından fundus, korpus ve antrumda mide ön ve arka duvar kalınlıkları ölçüldü. **Bulgular:** Grup 2 ve 7'de fundusun hem ön hem de arka duvarı diğer gruplara göre anlamlı derecede kalınlaşmış idi (p< 0.05). Fundus duvar kalınlığı bu iki grup arasında ise benzerdi (sırasıyla p= 0.67 ve p= 0.68). Korpus ve antrumun her iki duvarı grup 3'te diğer gruplara göre daha kalındı (p< 0.05). **Sonuç:** Bu çalışmada fonksiyonel dispepsili hastaların alt gruplarında mide duvar kalınlıkları arasında anlamlı farklılıklar tespit edilmiştir.

**Anahtar Kelimeler:** Dispepsi; gastrointestinal hastalıklar; ultrasonografi; mide hastalıkları

Türkiye Klinikleri J Med Sci 2010;30(3):1061-6

In the 60% of patients with upper abdominal pain or discomfort, establishment of a clinical diagnosis which could explain the symptoms is not possible even with invasive diagnostic procedures, and this entity is

termed as functional dyspepsia.<sup>1-5</sup> The existence of different functional dyspepsia subgroups has long been postulated because dyspeptic symptoms are intuitively suggestive of different underlying pathogenetic mechanisms.<sup>6-9</sup> Two main hypothetical subgroups were identified in almost all of the reports: “ulcer-like” and “dysmotility-like” dyspepsia, the former being characterized by several aspects of pain and the latter by symptoms suggestive of impaired gastroduodenal motility.<sup>7,8,10</sup>

Conventional transabdominal ultrasonic examination has a limited value for gas containing gastrointestinal tract since technical limitations do not permit a detailed evaluation of the wall or the endoluminal surface.<sup>11,12</sup> Transabdominal sonography of a water-filled stomach, hydrogastric sonography (HGS), is a recently introduced technique, and can improve the image quality during examination, allowing satisfactory visualization of the gastric wall and its disorders. This method has also been reported to have high sensitivity and specificity in the diagnosis and staging of gastric carcinomas.<sup>11,13</sup>

The etiology and optimal management of functional dyspepsia remains controversial. Increased sensitivity to gastric acid or altered gastric smooth muscle function or perception threshold to gastric distension due to inflammatory response to *H. pylori* without inflammation of the mucosa were set forth in etiology of functional dyspepsia in previous reports.<sup>14,15</sup> This sensitivity may cause inflammation in gastric wall especially in muscular layer and does not affect mucosa. So, endoscopic evaluation seems normal in these patients. However, this gastric wall inflammation may cause changes in gastric wall thickness. Therefore, this study was aimed to determine the actual gastric wall thicknesses in the subgroups of functional dyspepsia patients and to investigate whether there was any correlation with the symptoms.

## MATERIAL AND METHODS

The patients admitted with upper gastrointestinal symptoms to Surgery Department of Gaziosmanpaşa University Medical School who fulfilled Rome II criteria for functional dyspepsia<sup>16</sup> were selected for

this prospective study (n= 136; 36 males). After physical examination, they were evaluated by HGS following conventional transabdominal sonography after obtaining their informed consents. Upper gastrointestinal endoscopy and routine blood tests were performed when necessary. Patient care and follow up were held in accordance with the guidelines settled by Helsinki Declaration.

Control group consisted of twenty patients who underwent ultrasonographic examination for gynecologic or urinary reasons without any gastrointestinal symptoms or pathological findings during ultrasonography (group 1; 5 male). Age distribution of the groups were shown in Table 1. Functional dyspepsia patients were divided into six groups in regard to the predominant symptom; as group 2: epigastric discomfort (n: 27); group 3: epigastric pain (n: 32); group 4: nausea (n: 25); group 5: vomiting (n: 10); group 6: bloating (n: 24) and group 7: early satiety (n: 10). Patients complaining of more than one symptoms were asked to choose the most disturbing one as the predominant symptom. Patients were ingested  $693.65 \pm 87.13$  ml of tap water (BMI x 25 ml) prior to the examination after eight hours of starvation period. Body mass indices (BMI) was calculated by using the formula of weight in kilograms/(height in meters).<sup>2</sup> An experienced radiologist (MA) who was blind to the symptoms, clinical, and laboratory findings of the patients evaluated the structure of gastric wall by HGS. Both anterior and posterior gastric wall thicknesses in fundus, corpus and antrum were measured. During the examination, 3.5 MHz and 7.5 MHz transducers (LOGIQ 200 Pro Series, GE Me-

**TABLE 1:** Age distribution of the patients concerning groups.

Group	n	Mean	SD
1	20	46.52	15.46
2	27	51.89	3.59
3	32	52.31	4.49
4	25	49.80	4.41
5	10	50.70	1.88
6	24	49.33	4.15
7	10	48.90	1.37

dical Systems, Milwaukee, USA) were used. Following the gastric evaluation with 3.5 MHz convex transducer, the gastric wall thicknesses were measured with 7.5 MHz transducer. All the examinations were performed in supine position for antrum and corpus, and in left lateral decubitus position for fundus to obtain optimal image by removing the gastric gas from the examination area. During examination, patients were asked to swallow small amounts of water to allow identification of gastroesophageal junction and fundic measurements were performed superior to this level. Antral measurements were performed just proximal to pylorus, and corpus measurements were done at the mid-portion of the stomach proximal to incisura angularis. Image quality was increased during the examination of posterior wall by pressing the ultrasonographic probe.

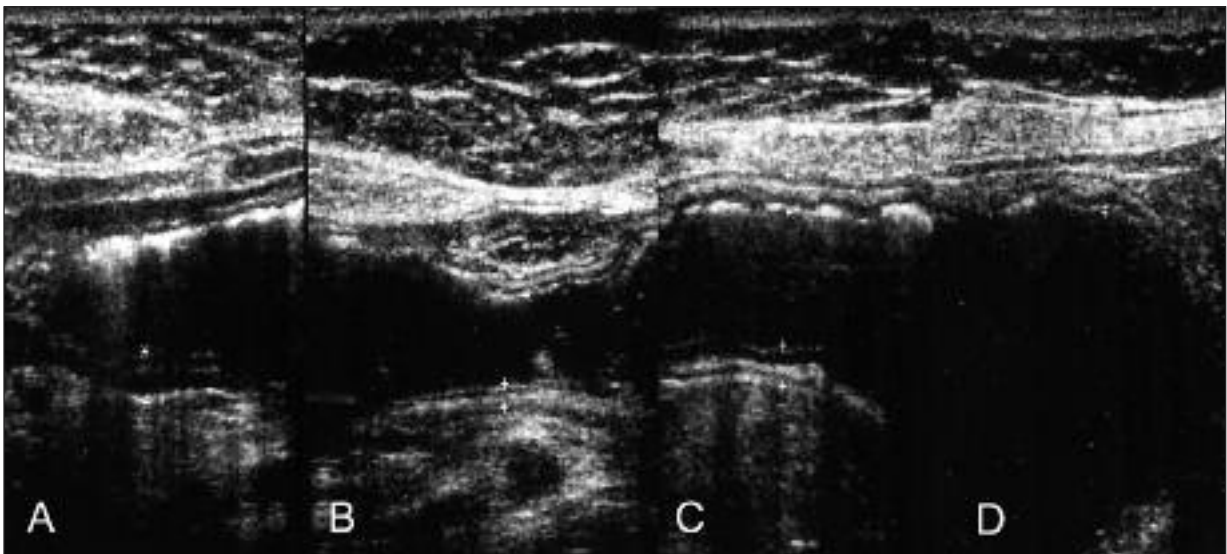
#### STATISTICAL ANALYSIS

One way analysis of variance (ANOVA) followed by Tukey HSD for post hoc analysis was used to assess the significance of wall thicknesses and body mass indices.  $P < 0.05$  was accepted for statistical significance.

## RESULTS

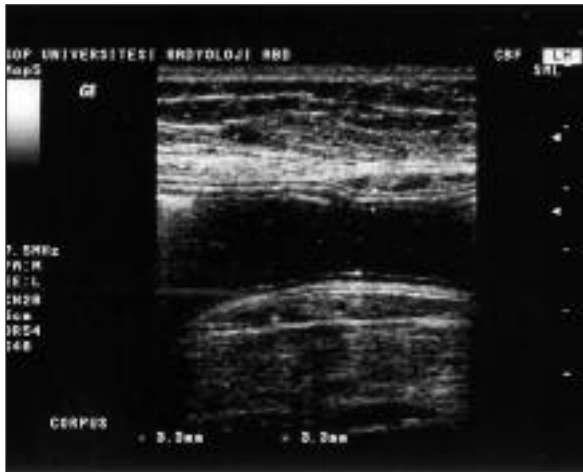
In all patients except eight who were excluded from the study because of unavailable optimal image quality owing to morbid obesity, it was possible to view the structure of gastric wall completely in detail (Figure 1). There was no statistically significant difference among the subgroups of functional dyspepsia population and the controls as far as the body mass indices were concerned ( $p > 0.05$ ). Five easily distinguishable layers of echogenicity were documented; layer 1 adjacent to the lumen represented the epithelial mucosa, layer 2 represented the deep mucosa, layer 3 represented the submucosa, layer 4 represented the muscularis propria and layer 5 represented the serosa. The layers 1,3,5 appeared as hyperechogenic and the others as hypoechoic layers in HGS (Figure 2a, b). The average total time required for HGS was 10.34 (6.30-17.15) minutes until the radiologist started taking pictures. The procedure was well tolerated by all the patients and no procedure related complications were detected.

The mean gastric wall thicknesses of the patients divided according to their symptoms are shown



**FIGURE 1:** Hydrosonographic anatomy of stomach.

- A:** Pylor and prepyloric antrum
- B:** Antrum-corpus transition
- C:** Corpus
- D:** Fundus



**A**  
**FIGURE 2A, B:** Anterior and posterior wall layers of stomach.

**B**

**TABLE 2:** The mean gastric wall thicknesses of the patients according to symptoms.

Group	n	Fundus (mean ± SD) (mm)		Corpus (mean ± SD) (mm)		Antrum (mean ± SD) (mm)	
		AW*	PW*	AW*	PW**	AW*	PW**
1	20	3.5350 ± 0.4056	3.4300 ± 0.4932	3.9800 ± 0.3622	3.8150 ± 0.3468	5.3950 ± 0.5987	5.2700 ± 0.6105
2	27	4.2000 ± 0.5684 <sup>#</sup>	4.1926± 0.5477 <sup>#</sup>	3.9704 ± 0.4008	3.8222 ± 0.4032	5.4444 ± 0.5423	5.2889 ± 0.5700
3	32	3.5156 ± 0.5635	3.3687 ± 0.5421	4.6688 ± 0.4795 <sup>#</sup>	4.3844 ± 0.8633 <sup>#</sup>	6.0969 ± 0.6916 <sup>#</sup>	5.9687 ± 0.6799 <sup>#</sup>
4	25	3.3400 ± 0.5008	3.2480 ± 0.3754	3.8920 ± 0.3378	3.7320 ± 0.3262	5.2640 ± 0.4966	5.1080 ± 0.4856
5	10	3.5500 ± 0.4503	3.5000 ± 0.3887	3.7800 ± 0.2658	3.7100 ± 0.2558	5.0500 ± 0.3028	4.8700 ± 0.2710
6	24	3.4833 ± 0.6431	3.4542 ± 0.5763	3.7958 ± 0.3689	3.6917 ± 0.3538	5.2792 ± 0.4917	5.0917 ± 0.4854
7	10	4.5300 ± 0.6617 <sup>#</sup>	4.4900 ± 0.4306 <sup>#</sup>	3.8500 ± 0.3028	3.7100 ± 0.2923	5.0500 ± 0.3028	4.9200 ± 0.2860
Total	148	3.6791 ± 0.6519	3.6054 ± 0.6334	4.0601 ± 0.5013	3.8912 ± 0.5635	5.4682 ± 0.6420	5.3176 ± 0.6488

\*Anterior wall.

\* Posterior wall.

<sup>#</sup> p< 0.05.

in Table 2. Both anterior and the posterior wall thicknesses of fundus, corpus and antrum were statistically significantly different among groups (F= 10.90; p< 0.0001, F= 15.45; p< 0.0001, F= 17.59; p< 0.0001, F= 6.63; p< 0.0001, F= 10.07; p< 0.0001, F= 10.85; p< 0.0001, respectively).

Anterior and posterior fundus walls were detected as significantly thickened in groups 2 and 7 (p< 0.05). While mean anterior wall of fundus was 4.20 ± 0.57 mm and the posterior was 4.19 ± 0.55 mm in group 2, they were 4.53 ± 0.66 mm and 4.49 ± 0.43 mm in group 7, respectively. The results we-

re similar for both anterior and posterior walls in these two groups ( $p=0.67$ ;  $p=0.68$  respectively).

Both anterior and the posterior walls of the corpus and antrum were significantly thicker than the other groups in the group 3 ( $p<0.05$ ).

## DISCUSSION

Functional dyspepsia is a clinical syndrome characterized by chronic or relapsing upper abdominal pain or discomfort, in the absence of underlying organ disease that can explain the symptoms.<sup>1,3,16</sup> The symptom complex includes epigastric pain, postprandial fullness, bloating, early satiety, nausea, vomiting, and epigastric discomfort, and these symptoms are often related to ingestion of a meal.<sup>3-5,9,17</sup> Because, symptom patterns vary greatly among dyspeptic patients, functional dyspepsia can be divided into subgroups with distinct demographic features and functional disturbances according to the predominant symptom type.<sup>18</sup> Recent studies have indicated a relationship between specific symptoms and the presence of pathophysiological mechanisms in functional dyspepsia without a structural explanation. The presence of impaired processing of a meal, abnormal upper gastrointestinal motility and visceral perception is associated with postprandial distress, nausea, bloating and early satiety in dyspeptic patients.<sup>19</sup> The presence of hypersensitivity to gastric distension and to gastric acid, with or without inflammation of the mucosa is associated with symptoms of epigastric pain, burning, early satiety, and weight loss.<sup>3,20</sup> A subset of dyspeptic patients has delayed gastric emptying of solids or liquids. Delayed gastric emptying of solids was constantly associated with postprandial fullness and with vomiting. Delayed emptying for liquids was also associated with postprandial fullness and with severe early satiety.<sup>21,22</sup> Even though our results can not match to any of pathophysiological mechanisms mentioned above, this is the first study provided evidence for structural changes in the stomach wall in functional dyspepsia patients.

Unidentified pathophysiology leads to absence of diagnostic certainty and lack of optimal treatment modalities for functional dyspepsia which

often implies that clinicians must follow a purely empiric therapeutic approach. Antacids, gastric acid secretion inhibitors, prokinetics, and psychopharmacological agents have all been tested. These agents appear to improve a variable fraction of treated patients but there are doubts about their actual efficacy.<sup>5,23</sup> We think that this study may orient further studies towards the gastric wall inside to clarify the pathophysiologic mechanisms and proper diagnosis of functional dyspepsia that can prevent patients from unnecessary invasive procedures and treatments.

Many authors have tried to assess the wall thicknesses of the gastrointestinal tract by the ultrasound, but a satisfactory agreement has not been achieved about normal and pathologic values, which is very important in order to direct the patients toward further investigations. During the abdominal ultrasonographic studies (with no water ingestion), normal gastric wall thickness was found up to 10 mm in one study, while other authors have established normal wall thickness up to 5 mm.<sup>24-26</sup> Numerous authors have clearly emphasized wall thickening as a key sonographic feature in diagnosis of gastrointestinal lesions.<sup>27-35</sup> We measured gastric wall thicknesses without water ingestion firstly. However, we could not obtain satisfactory images. It was very difficult to evaluate posterior wall and fundus. Water serves as an acoustic window to obtain better images and it becomes possible to evaluate posterior walls and fundus clearly. Our study also presents first available data for the anterior and posterior gastric wall thicknesses of antrum, corpus and fundus separately detected by HGS in functional dyspepsia patients and healthy individuals.

In conclusion, we evaluated gastric wall and measured gastric wall thicknesses in functional dyspepsia patients by HGS, and we found statistically significant differences at different sites of the stomach according to the symptoms of epigastric pain, discomfort and early satiety.

Functional dyspepsia is not a uniform disease; it affects different organs or different sites of the organs, and cause complex symptoms. As mentio-

ned before, different pathologic mechanisms cause different symptoms. We think that thickened part of the stomach may show inflammation site. This result can not explain the underlying pathogenetic

mechanisms; however, may orient further studies toward the gastric wall inside in order to better explain the underlying mechanisms of the functional dyspepsia.

## REFERENCES

- Malagelada JR. Functional dyspepsia. Insights on mechanisms and management strategies. *Gastroenterol Clin North Am* 1996;25(1):103-12.
- Talley NJ, Silverstein MD, Agréus L, Nyrén O, Sonnenberg A, Holtmann G. AGA technical review: evaluation of dyspepsia. *American Gastroenterological Association. Gastroenterology* 1998;114(3):582-95.
- Geeraerts B, Tack J. Functional dyspepsia: past, present, and future. *J Gastroenterol* 2008;43(4):251-5.
- Ochi M, Tominaga K, Iketani T, Kadouchi K, Tanigawa T, Shiba M, et al. Perfectionism underlying psychological background correlated with the symptoms of functional dyspepsia. *J Gastroenterol* 2008;43(9):699-704.
- Tack J, Talley NJ, Camilleri M, Holtmann G, Hu P, Malagelada JR, et al. Functional gastroduodenal disorders. *Gastroenterology* 2006;130(5):1466-79.
- Management of dyspepsia: report of a working party. *Lancet* 1988;1(8585):576-9.
- Talley NJ, Shuter B, McCrudden G, Jones M, Hoschl R, Piper DW. Lack of association between gastric emptying of solids and symptoms in nonulcer dyspepsia. *J Clin Gastroenterol* 1989;11(6):625-30.
- Talley NJ, Weaver AL, Tesmer DL, Zinsmeister AR. Lack of discriminant value of dyspepsia subgroups in patients referred for upper endoscopy. *Gastroenterology* 1993;105(5):1378-86.
- Tack J, Lee KJ. Pathophysiology and treatment of functional dyspepsia. *J Clin Gastroenterol* 2005;39(5 Suppl 3):S211-6.
- Veldhuyzen van Zanten S, Fedorak RN, Lambert J, Cohen L, Vanjaka A. Absence of symptomatic benefit of lansoprazole, clarithromycin, and amoxicillin triple therapy in eradication of *Helicobacter pylori* positive, functional (nonulcer) dyspepsia. *Am J Gastroenterol* 2003;98(9):1963-9.
- Düx M, Roeren T, Kuntz C, Richter GM, Kauffmann GW. TNM staging of gastrointestinal tumors by hydrosoneography: results of a histopathologically controlled study in 60 patients. *Abdom Imaging* 1997;22(1):24-34.
- Suk KT, Lim DW, Kim MY, Park DH, Kim KH, Kim JM, et al. Thickening of the gastric wall on transabdominal sonography: a sign of gastric cancer. *J Clin Ultrasound* 2008;36(8):462-6.
- Lee DH, Ko YT, Park SJ, Lim JW. Comparison of hydro-US and spiral CT in the staging of gastric cancer. *Clin Imaging* 2001;25(3):181-6.
- Holtmann G, Talley NJ. Functional dyspepsia. Current treatment recommendations. *Drugs* 1993;45(6):918-30.
- Talley NJ, Hunt RH. What role does *Helicobacter pylori* play in dyspepsia and nonulcer dyspepsia? Arguments for and against *H. pylori* being associated with dyspeptic symptoms. *Gastroenterology* 1997;113(6 Suppl):S67-77.
- Talley NJ, Stanghellini V, Heading RC, Koch KL, Malagelada JR, Tytgat GN. Functional gastroduodenal disorders. *Gut* 1999;45 Suppl 2:II37-42.
- Talley NJ, Phillips SF. Non-ulcer dyspepsia: potential causes and pathophysiology. *Ann Intern Med* 1988;108(6):865-79.
- Stanghellini V, Tosetti C, Paternicò A, De Giorgio R, Barbara G, Salvioli B, et al. Predominant symptoms identify different subgroups in functional dyspepsia. *Am J Gastroenterol* 1999;94(8):2080-5.
- Thumshirn M, Camilleri M, Saslow SB, Williams DE, Burton DD, Hanson RB. Gastric accommodation in non-ulcer dyspepsia and the roles of *Helicobacter pylori* infection and vagal function. *Gut* 1999;44(1):55-64.
- Perri F, Clemente R, Festa V, Annese V, Quitadamo M, Rutgeerts P, et al. Patterns of symptoms in functional dyspepsia: role of *Helicobacter pylori* infection and delayed gastric emptying. *Am J Gastroenterol* 1998;93(11):2082-8.
- Sarnelli G, Caenepeel P, Geypens B, Janssens J, Tack J. Symptoms associated with impaired gastric emptying of solids and liquids in functional dyspepsia. *Am J Gastroenterol* 2003;98(4):783-8.
- Caldarella MP, Azpiroz F, Malagelada JR. Antro-fundic dysfunctions in functional dyspepsia. *Gastroenterology* 2003;124(5):1220-9.
- Mearin F, Balboa A, Zárate N, Cucala M, Malagelada JR. Placebo in functional dyspepsia: symptomatic, gastrointestinal motor, and gastric sensorial responses. *Am J Gastroenterol* 1999;94(1):116-25.
- Bluth EI, Merritt CR, Sullivan MA. Ultrasonic evaluation of the stomach, small bowel, and colon. *Radiology* 1979;133(3 Pt 1):677-80.
- Fleischer AC, Muhletaler CA, James AE Jr. Sonographic assessment of the bowel wall. *AJR Am J Roentgenol* 1981;136(5):887-91.
- Derchi LE, Biggi E, Neumaier CE, Cicio GR. Ultrasonographic appearances of gastric cancer. *Br J Radiol* 1983;56(666):365-70.
- Worlicek H, Lutz H, Heyder N, Matek W. Ultrasound findings in Crohn's disease and ulcerative colitis: a prospective study. *J Clin Ultrasound* 1987;15(3):153-63.
- Kimmey MB, Wang KY, Haggitt RC, Mack LA, Silverstein FE. Diagnosis of inflammatory bowel disease with ultrasound. An in vitro study. *Invest Radiol* 1990;25(10):1085-90.
- Maconi G, Parente F, Bollani S, Cesana B, Bianchi Porro G. Abdominal ultrasound in the assessment of extent and activity of Crohn's disease: clinical significance and implication of bowel wall thickening. *Am J Gastroenterol* 1996;91(8):1604-9.
- Downey DB, Wilson SR. Pseudomembranous colitis: sonographic features. *Radiology* 1991;180(1):61-4.
- Truong M, Atri M, Bret PM, Reinhold C, Kintzen G, Thibodeau M, et al. Sonographic appearance of benign and malignant conditions of the colon. *AJR Am J Roentgenol* 1998;170(6):1451-5.
- Ranschaert E, Verhille R, Marchal G, Rigauts H, Ponette E. Sonographic diagnosis of ischemic colitis. *J Belge Radiol* 1994;77(4):166-8.
- Haber HP, Benda N, Fitzke G, Lang A, Langenberg M, Riethmüller J, et al. Colonic wall thickness measured by ultrasound: striking differences in patients with cystic fibrosis versus healthy controls. *Gut* 1997;40(3):406-11.
- Kimmey MB, Martin RW, Haggitt RC, Wang KY, Franklin DW, Silverstein FE. Histologic correlates of gastrointestinal ultrasound images. *Gastroenterology* 1989;96(2 Pt 1):433-41.
- Frisoli JK, Desser TS, Jeffrey RB. Thickened submucosal layer: a sonographic sign of acute gastrointestinal abnormality representing submucosal edema or hemorrhage. 2000 ARRS Executive Council Award II. American Roentgen Ray Society. *AJR Am J Roentgenol* 2000;175(6):1595-9.