Role of Hydrosonography of the small bowel
in the detection of
Inflammatory Bowel Disease & Small Bowel Tumors

Thesis Submitted for partial fulfillment of the Master Degree of Internal Medicine

By

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Abstract

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Abstract of Master's Thesis, Submitted October 2015:

Role of Hydrosonography of the small bowel

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Inflammatory Bowel Disease & Small Bowel Tumors

The aim of this thesis is to determine the diagnostic accuracy of hydrosonography as an initial method in diagnosis of inflammatory bowel disease and small bowel tumors.

Hydrosonography have been successfully used to diagnose of gynecological and obstetrical disease.

The role of hydrosonography of the small bowel has become increasingly important in the diagnostic workup and medical decision making for the small bowel disorders, both in acute and non-acute conditions.

Recently bowel ultrasonography is now becoming the first-line imaging procedure in patients with suspected Crohn's Disease for early diagnosis of the disease, and assessing patients suspected small bowel tumors.

This study was conducted in Egypt, sixty patients suspected bowel disease, hydrosonography was done to all patients.
Upper endoscopy and colonoscopy, serology or imaging necessarily to reach the final diagnosis.

The results of the thesis show that hydrosonography is important in the diagnostic workup in patients with suspected Inflammatory bowel disease for early diagnosis and suspicion of small bowel tumors.

Key Words: chronic diarrhea, chronic abdominal pain, bowel hydrosonography, inflammatory bowel disease, small bowel tumors.

■ List of Content :

■ List of abbreviations :

AO	Abdominal Aorta
BWT	Bowel Wall Thickness
CBC	Complete Blood Count
CD	Crohn's Disease
CDAI	Crohn's Disease Activity Index
CT scan	Computerized Tomography scan
ESR	Erythrocyte Sedimentation Rate
EUS	Endoscopic UltraSound
IBD	Inflammatory Bowel Disease
IBDU	Inflammatory Bowel Disease Undetermined
IBS	Irritable Bowel Syndrome
IC	Intermediate Colitis
IMA	Inferior Mesenteric Artery
pANCA	p-AntiNeutrophil Cytoplasmic Antibodies
PEG	PolyEthylene glycol
PET	Positron Emission Tomography
PV	Portal Vein
SICUS	Small Intestine Contrast Ultrasonography
SMA	Superior Mesenteric Artery
SMT	Small Bowel Tumors
Th-1	T-helper-1 cells
Th-2	T-helper-2 cells
UC	Ulcerative Colitis
US	UltraSound

■ List of Tables :

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■Introduction:

Abdominal ultrasonography is a great way to examine abdominal organs. It's readily available, portable, cheap and non-invasive. If we distend the bowel loops with an oral non-absorbable fluid, the bowel loops can be examined with ultrasonograpahy as well. This method of examination is called hydrosonography. Bowel US can be improved by filling the bowel with water or echo-poor liquids, either directly infused into the small bowel using a nasal-jejunal tube and a peristaltic pump, or administered orally. In both cases, the liquid contrast medium should be non-absorbable and non-fermentable.

IBD is a chronic disease with remission and exacerbation and variable response to therapy needing repeated evaluation. A non-invasive tool of diagnosis would be of great value in the evaluation and follow up of such patients. Ultrasound and color Doppler were reported to be of promising value to attain such objective (***Wilson, 2011***).

Advances in the understanding of bowel appearances with high resolution sonography have led to consideration of this technique as an important tool for bowel disease assessment. Ultrasonography may display the transformation of the intestinal wall from normal to pathological state in inflammatory disease. Furthermore, intestinal ultrasonography may serve as a diagnostic clue if typical patterns of the bowel wall are demonstrated (***Allygar et al., 2011***).

Abdominal sonography as a non-invasive diagnostic method has proven to be of great value in evaluating patients with acute and chronic IBD.The ultrasound pattern of bowel inflammation is characterized by thickened and hypoechoic inflamed bowel wall (***Nylund et al, 2009***).

Hydrosonography is a useful procedure in screening for intra-cavitary pathologies and allows differentiation of intra-cavitary, endometrial, and submucosal abnormalities (***Guven, 2004***).

Hydrosonographyhas become increasingly important in the diagnostic work-up and medical decision making for gastrointestinal disorders, both in acute and non-acute conditions. Recently bowel ultrasonography is becoming the first-line imaging procedure in patients with suspected CD for early diagnosis of the disease (***Parente, 2004***).

Similarly, color Doppler can be used as a non-invasive method to evaluate the vascular changes which develop in splanchnic circulation and the bowel wall of patients with IBD.Thickened and hypervascularized bowel wall is characteristic findings in IBD. Power Doppler sonographyoffers an additional non-invasive procedure for the determination of activity in patients with IBD (***Hagiu & Radu, 2007***).

Color Doppler can identify increased vascularity associated with gastrointestinal inflammatory conditions. It has been suggested that specific diagnosis can be established based on flow patterns. Mucosal or transmural hypervascularity on color Doppler can be seen with several inflammatory bowel processes (***Homann et al, 2005***).

Doppler can demonstrate splanchnic hemodynamic changes inactive IBD patients and can be used to differentiate between active andquiescent cases(***Maconi et al., 2002***).

■Aim of Work:

The aim of this study is to determine the diagnostic accuracy of hydrosonography as an initial method in diagnosis of inflammatory bowel disease and small bowel tumors.

■ Review :

1- Sonographic Anatomy of the Bowel.

2- Hydro-Sonography.

3- Inflammatory Bowel Disease.

4- Small Bowel Tumors.

5- Sonographic Manifestations of Crohn's disease (CD).

6- Sonographic Manifestations of Ulcerative Colitis (UC).

7- Sonographic Manifestations of Small Bowel Tumors.

1- Sonographic anatomy of the bowel

- **Normal ultrasound anatomy;**

① Duodenum :

The duodenal bulb follows the pyloric stricture. The second duodenum descends vertically at the contact of the gallbladder and surrounding the pancreas head. Duodenum patterns are variable and should not be confused with pathological collections. A prolonged observation will show filling and emptying movements. The third duodenum is visible between the aorta and the superior mesenteric artery (***Lichtenstein, 2005***).

② Small Bowel :

It is almost always possible to visualize at least some loops of the small bowel (***Lichtenstein, 2005***).
Small intestinal loops are in the midabdomen, Small bowel loops can be recognized by the presence of valvulae conniventes when the lumen is filled with fluid (***O'Malley and Wilson, 2003***).

The jejunum is recognized by the endoluminal presence of villi. The ileum has a tubular, regular pattern (***Lichtenstein, 2005***).

Acute disorders of the bowel affect the whole of the bowel. Consequently, ultrasound analysis of an even small portion can be rich in information. Many relevant items can be extracted:
1. Peristalsis gives a permanent crawling dynamics, with regular contractions. A present peristalsis can be objectified in a few seconds. This is the usual pattern in the normal subject. Prolonged observation (at least 1 min) seems necessary to affirm abolition of peristalsis.
2. The normal caliper of the small bowel is approximately 12–13 mm.
3. Contents can have either a homogeneous echoic or hypoechoic pattern.
4. Wall thickness ranges from 2 to 4 mm. Fine analysis of the wall is greatly facilitated when there is liquid contrast from both sides, i.e., peritoneal effusion associated with fluid content, two conditions often present in acute disorders (***Lichtenstein, 2005***).

The terminal ileum is very often, resting on top of the psoas muscle It can be followed distally to the cecum. The small intestine is recognized by the presence of motility and mucosal folds (plicae circulares). It also has a tortuous course, contains air, and is easily compressible; the jejunum has slightly more mucosal folds and a larger diameter than the ileum. Another marker; the jejunum is mainly located in the umbilical region, whereas the ileum is mainly in the hypogastrium and the pelvic area (***Nylund et al., 2010***).

③ The colon :

The colon is a tubular structure with visible haustra, without identifiable peristalsis. Roughly, the ascending and descending colon are vertical structures located in the flanks, the transverse colon is horizontal at the epigastric level and distinct from the stomach (***Lichtenstein, 2005***).

The colon is located in the periphery of the abdomen with the cecum and ascending colon laterodorsally on the right side of the abdomen and the descending colon laterodorsally on the left side. The right colonic flexure is usually found just behind the lower portion of the right liver lobe and the splenic flexure just below the spleen. The location of the transverse and the sigmoid colon may vary significantly due to the varying length of their mesocolon. The watershed between the two visceral arteries is in the distal transverse colon near the splenic flexure which explains the distribution of affected colonic segments in ischemic disease (***Hollerweger, 2007***).

To examine the colon, the examiner returns to the right iliac fossa and follows the ileum to the cecum. The appendix can be identified as a structure leaving the cecum and ending, It is frequently seen lying between the terminal ileum and the right psoas muscle (***Nylund et al., 2010***).

On US, the colon is characterised by its typical haustration (***O'Malley and Wilson, 2003***). The right hemicolon is usually filled with stool and gas whereas the left hemicolon is often seen in a contracted condition [**Fig. 1**]. The diameter of the colon usually measures up to 5 cm, whereas that of the cecum may exceed this width (***Hollerweger, 2007***).

[**Fig. 1**] **Sonographic identification of the colon**.
The longitudinal section of the normal ascending colon (***a***) shows the typical haustration pattern. The bowel wall is very thin and barely visible. On a cross-section of the contracted sigmoid colon on its course over the iliac vessels (***b***) the different bowel wall layers are visible(***c***) normal transverse colon is seen in a longitudinal section with obvious haustra. The fecal matter is mixed with gas (***Hollerweger, 2007***).

④ Appendix :

In a healthy person, the appendix is usually not visible during the sonographic screening. Nonetheless, in a very small percentage of patients, a normal appendix is visible with sonography. The appendix arises from the site at which three taenia unite and varies considerably in length and width, averaging 5 to 10 cm in length. It is usually curved and maybe tortuous (***Chen, 2005***). The position of the appendix is highly variable. Antrocaecal position or a position within the small pelvis may be found (***Gritzmann, 2007***).

The normal appendix can be differentiated from the small bowel loops by the absence of peristalsis and intraluminal chylous flow and lack of changes in configuration over time (***Chen, 2005***).

▪ Normal sonographic bowel wall anatomy;

· Sonoanatomy of bowel wall;

Histologically, the bowel wall is comprised of several distinct layers. These layers include (i) the mucous membrane, which is made up of the epithelium, lamina propria, and muscularis mucosa; (ii) the submucosa; (iii) the muscularis propria, which is made up of the inner circular layer and the outer longitudinal layer; and (iv) the serosa (***Nino-Murcia and Jeffrey, 2008***).

On routine transabdominal scanning, the normal bowel may appear as a collapsed structure with an echogenic center and a hypoechoic bowel wall surrounded by a more echogenic peripheral zone. However, this appearance varies, depending on which portion of the gastrointestinal tract is identified and whether the bowel is collapsed or fluid filled. When the bowel is fluid filled, it appears as an echogenic wall surrounding the central fluid-filled lumen. Occasionally, discrete layers of the bowel wall may be identified on transabdominal scanning. However, with transducers in the 3.5 to 6 MHz range, the most prominent feature of the normal bowel is often the echogenic submucosal layer (***Nino-Murcia and Jeffrey, 2008***).

High resolution transducers usually permit visualization of the five layers of the intestine and stomach walls (***Dietrich et al., 2007***).

These include three echogenic layers and two hypoechoic layers. The different layers with their histologic correlations include (i) the echogenic superficial mucosa, including the luminal contents and the mucosal inner face; (ii) the hypoechoic, deep mucosa, which also includes the muscularis mucosa; (iii) the echogenic submucosa, which includes the interface between the submucosa and the muscularis propria; (iv) the hypoechoic muscularis propria; and (v) the echogenic serosa, which includes the serosal surface and the serosal fat (***Nino-Murcia and Jeffrey, 2008***).The GI wall has a normal stratification if five US layers are visible, and