Inflammatory Bowel Disease: Imaging Modalities of Crohn’s Disease and Ulcerative Colitis.

Abstract

There are two common types of Inflammatory Bowel Disease (IBD), Crohn’s Disease and Ulcerative Colitis. Crohn’s Disease is a type of IBD that is characterized by intestinal ulceration that affects the entire gastrointestinal tract. For over a decade, physicians have been able to evaluate Crohn’s Disease by using new modalities such as Capsule Endoscopy, Balloon-assisted Endoscopy, and Computed Tomography Endoscopy. New modalities such as these help physicians make an earlier diagnosis that could lead to better treatment. There are many different radiographic techniques that can be used to evaluate inflammatory bowel disease. They include; plan radiographic film, upper and lower GI, and a barium enema. These techniques are used to guide the physician on the right track to diagnosis of IBD. These imaging modalities can bring a diagnosis that will help determine which treatment best suites the patient.

Literature Review

Inflammatory bowel disease (IBD) involves chronic inflammation of all or part of the digestive tract. The two most common types of IBD are also the most severe and chronic. They include Ulcerative Colitis and Crohn’s Disease. Over 1 million Americans are estimated to have one of these two forms of IBD. Both of these diseases have very similar symptoms that can vary from abdominal cramping, bloody or watery diarrhea, ulcers, and inflammation of the gastrointestinal tract lining. These symptoms may also have an emotional burden on a person’s life. Although these two diseases have similar aspects, they are differentiated by location of the ulcerated and inflamed tissue and the nature of the ulcerous lesions.

Crohn’s Disease first begins as inflammation in the lower part of the small bowel known as the ileum, however, it has also been known to begin in other places such as the rectum, stomach, esophagus or even the mouth. Crohn’s Disease usually drives inflammation deep into the walls of the affected tissue. This disease can also create lesions that ulcerate beyond the bowel lining, scar the tissue, and create thickening of the bowel wall. Ulcerative Colitis starts in the inner lining of the rectum and colon and uniformly inflames a section of the colon’s inner lining. Patients who have one of these two severe forms of inflammatory bowel disease usually
never have the same treatment or outcomes. Each patient could have a different severity level and some will require more exams, treatment and possibly surgery than other patients.\textsuperscript{1}(p. 291)

Inflammatory Bowel Disease is characterized by intestinal ulceration that affects the entire gastrointestinal tract. One of the procedures used to evaluate IBD is Push Enteroscopy. Push Enteroscopy has the ability to go in places of the small bowel that standard colonoscopy and endoscopy procedures cannot reach. “Push Enteroscopy was the standard modality for evaluating subtle mucosal changes in the small bowel in patients with Crohn’s Disease, however, this technique only allows limited endoscopic access for diagnosis and treatment.”\textsuperscript{4}(p.322) For over a decade, physicians have evaluated Crohn’s Disease by using modalities such as Capsule Endoscopy, Balloon-assisted Endoscopy, and Spiral Endoscopy. Modalities such as these can lead to an earlier diagnosis and treatment. \textsuperscript{4}

Computed Tomography Enteroscopy

Computed Tomography Enteroscopy (CTE) is a diagnostic procedure that uses computed tomography imaging and a contrast material for a better view of the interior of the small intestine. CTE is a great tool used to help evaluate the small intestine with patients that have inflammatory bowel disease. CTE was first introduced in 1997 as a modified abdominopelvic CT examination to specifically examine the small bowel. This is to evaluate the extent and severity of Crohn’s Disease. In order to create a good picture of the small intestine, adequate luminal distention is a prerequisite for CTE. In this procedure the technologist will use oral and intravenously administered contrast to help optimize and enhance the small bowel wall. CTE is a non-invasive procedure that can give physicians relevant information in diagnosing patients with Crohn’s Disease, Intestinal Tuberculosis, and Intestinal Behcet Disease.\textsuperscript{5}

\textbf{Total Aspects of Ulcerative Colitis}

Ulcerative Colitis is a chronic and systemic disease of the large intestine where it becomes inflamed and develops tiny open sores and ulcers that can produce pus and mucous. This disease is a result of an abnormal response to the body’s immune system. The immune system, in normal cases, uses cells to help fight infection. In patients that have Ulcerative Colitis, the immune system mistakes food, bacteria, and other materials in the intestine for foreign or invading substances. Once this happens, the immune system will send white blood cells into the lining of the intestines and cause chronic inflammation and ulcerations. In most cases of Ulcerative Colitis, the inflammation can cause loss of the lining of the large intestine that can
lead to bleeding, production of pus, diarrhea, and abdominal discomfort. The inflammation normally begins in the rectum and sigmoid portion of the lower intestine and progresses to involve the entire rectum. There is no simple cure for Ulcerative Colitis. There are drug therapies that help reduce the signs and symptoms, and sometimes long-term remission from this disease can be induced. Surgery is another option, in severe cases, to help eliminate symptoms by removing the entire diseased colon and rectum.\(^1\)\(^3\)

**Total Aspects of Crohn’s Disease**

Crohn’s Disease (CD) is a type of Inflammatory Bowel Disease that is characterized by intestinal ulceration that affects the entire gastrointestinal tract. Crohn’s Disease most commonly affects the distal and terminal ileum of the small bowel (See Figure 1). CD can also be called Ileitis or Enteritis and starts in the small intestine, which scatters sores on the lining of the Ileum. The signs and symptoms of Crohn’s Disease are similar to those of Ulcerative Colitis, which can develop gradually or present suddenly.\(^1\)\(^3\)

Crohn’s Disease (CD) starts out with small sores that become inflamed. These inflamed sores can appear in a patient’s mouth and throat, which may make it hard for them to swallow foods. CD can form several patches of inflamed sores leaving healthy tissue in between. It can cause diarrhea that happens when the inflammation causes cells in the affected area to secrete large amounts of water and salt: thus the colon is not able to absorb properly. The inflammation can cause the bowel walls to swell and thicken with scar tissue. This can affect the normal movement of fecal matter through the digestive tract and can lead to extreme cramping and pain that can cause nausea and vomiting. Fecal matter may contain blood that cannot be seen. A patient may possibly need a stool occult blood test that can inform physicians of blood in the stool. Bleeding stool can cause severe problems. Patients with severe CD can have multiple bowel movements a day. Over a period of time, the inflammation of the sores can cause them to become large ulcers that form deep into the walls of the digestive tract. CD can cause a high fever, fatigue, joint and eye inflammation, skin disorders, and inflammation of the liver.\(^1\)\(^3\)

**Diagnostic Procedures and Their Benefits and Risks**

*Class I: Capsule Endoscopy*

Capsule Endoscopy is an imaging device that records images of the digestive tract. It is also used after a gastroscopy or colonoscopy if a patient’s results come back negative but is still
having gastrointestinal bleeding. Capsule Endoscopy has detected small bowel lesions in Crohn’s Disease patients where other modalities have missed. The Capsule Endoscopy is a small camera that is easy to swallow, disposable, and wireless making it easy to visualize the gastrointestinal mucosa. The capsule is only 11mm x 26mm and only weighs 3.7g (see Figure 2). The capsule holds a metal oxide semiconductor imaging chip video camera, 6 white light-emitting diode illumination sources, two silver-oxide batteries, and a radio telemetry transmitter. The capsules imaging field will show a full 140 degrees and has a magnification of 8. It also has a depth view between 1mm and 30mm.6

One of the main complaints of the capsule is retention. Retention is defined when the capsule has been in the digestive tract for a minimum of two weeks. This can mean that the patient needs to go into surgery to remove the capsule. This problem varies by patient. Patients who are healthy have a 0% chance of retention happening. A patient who is suspected of having Crohn’s Disease has a 21% chance of retention with a bowel obstruction (see Figure 7). There are also some limiting factors that come with using Capsule Endoscopy. The endoscopic capsule cannot be used to obtain a biopsy specimen and is unable to be controlled remotely. If the camera finds a lesion, most likely, the patient would need to have a colonoscopy to obtain a biopsy sample.6,9

Class II: Balloon-assisted Endoscopy

There are two types of Balloon-assisted Endoscopies (BAE), Double-balloon Endoscopy and Single-balloon Endoscopy. Double-balloon Endoscopy is a very unique procedure that has two balloons where one is attached to the tip of the endoscope and the other to the distal end of the accompanying over tube balloon. The BAE was developed as a new technique used to visualize the small bowel. This procedure is usually done in Interventional Radiology. The advantage of BAE is being able to biopsy a specimen by going deep inside the small intestine. Yamagamie et al1 determined that 13 out of 20 consecutive patients had shown endoscopic lesions in the small bowel and 12 out of the 13 showed inflammation which was confirmed by histopathological examination. The disadvantage of BAE is its invasiveness and it requires sedation. When performing a BAE, patients with inflammatory bowel disease need to have special attention not inflate the over tube balloon on the deep ulcerative mucosa. This will help avoid any intestinal perforation. Active Crohn’s Disease lesions tend to develop on the mesenteric side of the bowel wall, and in some cases it is relatively difficult to examine the
mesenteric side using BAE. This is because the ileum can twist toward the mesenteric side and
the view of the scope can tend to skew toward the antimesenteric side. This could lead to missing
important anatomy such as active deep ulcers even in the presence of longitudinal ulcers.\textsuperscript{4}

\textbf{Class III: Computed Tomography Enterography}

Computed Tomography Enterography (CTE) is a diagnostic procedure that uses
computed tomography imaging and a contrast material for a better view of the interior of the
small intestine. CTE is a great non-invasive procedure that can help visualize inflammatory
bowel disease. It is important that the luminal be distended. A low neutral or low dense oral
contrast agent helps to distend the lumen. The procedure requires the use of an intravenously
administered contrast that will enhance the bowel wall and maximize conspicuity of small bowel
pathology.\textsuperscript{5}

Crohn’s Disease has a variety of different appearances depending on whether the activity
is acute inflammatory or chronic fibrostenosing and whether there are complications such as a
fistula or abscess. When you see wall thickening in the small intestines on a CTE, this suggests
active inflammatory Crohn’s Disease. Some studies have shown that mural hyperenhancement
may be a more sensitive sign of showing Crohn’s Disease. “Mural hyperenhancement refers to
segmental hyperenhancement of the small bowel wall compared with the adjacent small bowel
loops.”\textsuperscript{5 (p328)} When reviewing images, it is important to compare the bowel loops with similar
degrees of distension. Normal collapsed loops of bowel show greater attenuation over the
distended bowel loops (see Figure 6). Approximately 82\% of patients with Crohn’s Disease
present with thickening bowel walls of greater than 3 mm in a distended bowel loop.\textsuperscript{5}

CTE can also be used to assess treatment with patients that have Crohn’s Disease. Mural
hyperenhancement and bowel wall thickening are the most sensitive signs of active disease
shown on CTE, which gives the physician an idea on the progressiveness of the disease. After
effective therapy, using a combination of clinical, endoscopic, pathologic, and laboratory
findings, CTE can show the decrease in mural hyperenhancement and bowel wall thickening.
CTE is a great tool for diagnosing and to help evaluate a treatment for Crohn’s Disease. This a
great non-invasive procedure that can offer so much information for inflammatory bowel
disease.\textsuperscript{5}

\textbf{Class IV: Radiologic Techniques}
There are many different types of radiologic procedures that can be utilized for inflammatory bowel disease. These procedures can provide important information that endoscopic exams and histologic tests cannot provide. These procedures consist of three-way abdomen series, Upper and Lower GI, and small bowel series. These procedures can be used when an endoscopy is unable to view parts of the intestinal tract.¹

Plain films examine the abdominal portion of the body that can help reveal certain complications of inflammatory bowel disease. These radiographs can show a small bowel obstruction, obstruction and dilation of the large bowel which can occur with Crohn’s Disease, and toxic mega colon that occurs with ulcerative colitis. Some procedures can use contrast to help see the intestinal tract better. Most contrast procedures need at least a day preparation to clearly empty the intestinal tract. Contrast studies first start out by taking a scout KUB, to make sure the GI tract is completely empty. Once the GI tract has been proven empty, barium is ingested to line the intestinal tract. This will visualize irregular forms of the intestinal wall.

The Barium Enema procedure is used to study the lower intestinal tract (see Figure 3). This procedure is normally used when the colonoscopy comes back inconclusive. This procedure uses barium that is inserted in the rectum that can show irregular lining of the intestinal wall that can be consistent with Crohn’s Disease.¹

An Upper GI and small bowel follow through is another barium procedure that studies the esophagus, stomach, duodenum, and small intestine. Barium coats the stomach and intestinal lining to help visualize the outer lining walls. The Upper GI can show a blockage, abnormal growth, ulcers, and obstruction which is consistent with Crohn’s Disease (see Figure 4).¹

Case Study: Increased Risk of IBD

There are many bowel related complications with Crohn’s Disease. Patients with Crohn’s Disease have a much higher risk for small bowel and colonic adenocarcinoma and lymphoma. A twenty-five year old male with Crohn’s Disease presented with abdominal pain. A CT was performed and demonstrated thickening of a loop of small bowel in the pelvis. This patient had irregular thickening of the small bowel near the pelvis that couldn’t rule out a malignant tumor. After the patient underwent surgery, it was found that he had small bowel adenocarcinoma (see Figure 5). This corresponds to the most common site of inflammation in Crohn’s Disease patients. The most common site of small bowel adenocarcinoma is the distal and terminal part of
the ileum. Patients with Crohn’s Disease have a 15 to 50 times greater chance of small bowel adenocarcinoma than the general public.  

**Therapy Treatments**

*Class I: Drug Therapies*

Drug therapy is a good start in treating IBD. Patients with Crohn’s Disease or Ulcerative Colitis will have their own drug therapy depending on the severity of symptoms. There are five basic categories of medication used to treat IBD. These include amino salicylates, immunomodulators, corticosteroids, antibiotics, and biologic therapies. Amino salicylates are a compound of 5-aminosalicylic acids. This treatment is affective in patients with moderate episodes of IBD and will also help prevent relapses and maintain remission. Immunomodulators are a great way to suppress the immune system to help block inflammation. This weakens the activity of the immune system by suppressing the bone marrow which helps decrease inflammation. Patients on this therapy will be carefully monitored due to the severe side effects.  

Corticosteroids have been the main treatment for acute flare-ups with IBD. These steroids come with common side effects such as elevated blood pressure, rounding of the face, increased infection risk, weight gain, acne, mood swings, growth of facial hair and cataracts. These steroids can reduce inflammation and induce remission, particularly in those who have severe active Crohn’s Disease. Corticosteroids are for short-term use only. Antibiotics are another source of treatment for Crohn’s Disease but are not helpful for patients who have Ulcerative Colitis unless presence of toxic mega colon is identified. Antibiotics help patients with Crohn’s Disease by reducing bacteria in the intestines and directly suppressing the immune system. Biological therapies interfere with the body’s inflammatory response by targeting specific molecules. This can target the inflammation that deals with IBD and decrease inflammation in the intestinal walls.  

*Class II: Ulcerative Colitis and Crohn’s Disease Surgery Therapy*

Surgery is another option if the IBD is too severe for drug therapy treatment alone. Between 25% and 40% of patients with Ulcerative Colitis will eventually need surgery. The best surgical treatment for Ulcerative Colitis is to remove part of the affected area of the bowel. This is known as Proctocolectomy. Patients with Crohn’s Disease often have a combination of drug and surgical therapies. Three out of four patients with Crohn’s Disease will eventually need
some sort of surgery. Surgery is usually required when drug therapies have stopped working to control symptoms. This could include a blockage in the intestine, abscess, scar tissue, fistula, perforation or severe bleeding into the intestines (see Figure 8).¹

**Conclusion**

Inflammatory Bowel Disease is a complex disease that involves the gastrointestinal system that includes the stomach down to the rectum and is the process that involves inflammation in the gastrointestinal system. Crohn’s Disease and Ulcerative Colitis are the two most severe and chronic forms of the disease. Patients with these severe forms often experience multiple debilitating symptoms. These symptoms include inflammation of ulcers in the lining of the GI tract, severe bloody or watery diarrhea, abdominal cramping, vomiting, and pain. Patients with symptoms such as these need imaging to diagnose the severity of the disease.

There are many procedures that help identify the type and severity of IBD. Small bowel endoscopic procedures, CTE, and radiologic techniques. Small bowel endoscopic procedures such as CE and Balloon-assisted Endoscopy have been developed to look at the intestinal walls. CE is a non-invasive method that requires no sedation and Balloon-assisted Endoscopy can be performed without worrying about capsule retention, biopsy specimen collection, and can be used to dilate strictures. Both of these procedures are unique in how they visualize the small bowel. CTE allows the identification of intramural and extra intestinal sign of IBD. CTE can be used to find specific features of the disease determines the form of treatment. Radiologic techniques can be used as the first step in finding IBD. A 3-vew abdominal series can show an obstruction that could be caused by IBD. Barium studies are also helpful in determining the damage of the intestinal walls. Even though drug therapies and surgical procedures can help reduce symptoms, they cannot cure IBD. Regular diagnostic exams, drug therapy and surgical treatments can help give patients with severe IBD a much better quality of life.
References


Figures

**Figure 1.** Active Crohn’s Disease: Each CT shows a different patient that has Crohn’s Disease and how the disease effects the intestines. Image courtesy of: Siva P Rama, Karen M Horton, Elliot K Fishman. Computed tomography of Crohn’s Disease: The Role of Three Dimensional Technique. World Journal of Radiology 2013 May 28; 5(5): 193-201
Figure 2. *The size of the capsule is only 11mm x 26mm and only weighs 3.7g. Image Courtesy of: Mayo Clinic. Capsule Endoscopy. http://www.mayoclinic.com/health/medical/IM04443. Accessed November 16, 2013.*
**Figure 3.** This barium enema procedure shows an irregular intestinal wall that helps diagnose Crohn’s Disease. Image courtesy of: L. Jodell McLEMORE. Inflammatory Bowel Disease. Radiologic Technology, 2007; 78(4):291-305.
Figure 4. This is a small bowel follow through showing pathology of nodular and ulcerated terminal ileum. This is consistent with Crohn’s Disease. Image courtesy of: L. Jodell McLEMORE. Inflammatory Bowel Disease. Radiologic Technology, 2007; 78(4):291-305.
Figure 5. A: 84 year old presented with abdominal pain. A CT was ordered and shows multiple dilated loops of small bowel, showing a possible small bowel obstruction. B: 49 year old male with Crohn’s Disease demonstrates focal thickening of the hepatic flexure of the colon. C: 24 year old female with Crohn’s shows dilated loops of small bowel. D: 25 year old male with Crohn’s shows thickening of a loop of small bowel in the pelvis. E: 51 year old female with a history of Crohn’s demonstrates nodular soft tissue thickening surrounding an right abdomen. Image Courtesy of: Siva P Rama, Karen M Horton, Elliot K Fishman. Computed tomography of Crohn’s disease: The Role of Three Dimensional Technique. World Journal of Radiology 2013 May 28; 5(5): 193-201
Figure 6. A 32 year old man’s axial computed tomography enterography image shows a segmental stricture involving proximal ileal loop. Homogenous mural thickening is seen at the strictured segment. This is consistent with Fibrostenosing Cohn Disease. Image courtesy of: Park MJ, Lim JS. Computed tomography enterography for evaluation of inflammatory bowel disease. Clin Endosc. 2013;46(4):327-366
Figure 7. This shows an endoscopic capsule stuck in the intestines. This patient will need surgery to take out the capsule. Patients with Crohn’s Disease have a high retention rate. Image Courtesy of: Khaled M. Elsayes, Mahmoud M. Al-Hawary, Jagalpathy Jagdish, Halemane S. Ganesh, and Joel F. Platt. CT Enterography: Principles, Trends, and Interpretation of Findings. RSNA RadioGraphics 2010 30:7, 1955-1970
Figure 8. This is a small bowel follow through that shows a distal ileal strictures and an enterovaginal fistual. Image courtesy of: L. Jodell McLEMORE. Inflammatory Bowel Disease. Radiologic Technology, 2007; 78(4):291-305.