

CHAPTER: Large Bowel

Chapter: Large Bowel

Preface

Undergraduate teaching of radiology in Europe is provided according to national schemes and may vary considerably from one academic institution to another. Sometimes, the field of radiology is considered as a "cross-cutting discipline" or taught within the context of other clinical disciplines, e.g., internal medicine or surgery.

This e-book has been created in order to serve medical students and academic teachers throughout Europe to understand and teach radiology as a whole coherent discipline, respectively. Its contents are based on the *Undergraduate Level of the ESR European Training Curriculum for Radiology* and summarize the so-called *core elements* that may be considered as the basics that every medical student should be familiar with. Although specific radiologic diagnostic skills for image interpretation cannot be acquired by all students and rather belong to the learning objectives of the *Postgraduate Levels of the ESR Training Curricula*, the present eBook also contains some *further insights* related to modern imaging in the form of examples of key pathologies, as seen by the different imaging modalities. These are intended to give the interested undergraduate student an understanding of modern radiology, reflecting its multidisciplinary character as an organ-based specialty.

We would like to extend our special thanks to the authors and members of the ESR Education Committee who have contributed to this eBook, to Carlo Catalano, Andrea Laghi and András Palkó who initiated this project, and to the ESR Office, in particular Bettina Leimberger and Danijel Lepir, for all their support in realising this project.

We hope that this e-book may fulfil its purpose as a useful tool for undergraduate academic radiology teaching.

Minerva Becker ESR Education Committee Chair Vicky Goh ESR Undergraduate Education Subcommittee Chair

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Copyright and Terms of Use

This work is licensed under a <u>Creative Commons Attribution-NonCommercial-NoDerivatives 4.0 International</u> <u>License</u>.

You are free to:

• Share – copy and redistribute the material in any medium or format

Under the following terms:

- Attribution You must give <u>appropriate credit</u>, provide a link to the license, and <u>indicate if changes were</u> <u>made</u>. You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use.
- NonCommercial You may not use the material for <u>commercial purposes</u>.
- NoDerivatives If you <u>remix, transform, or build upon</u> the material, you may not distribute the modified material.

How to cite this work:

European Society of Radiology, Anisha Bhagwanani, Vivienne Eze, Stuart Taylor (2022) eBook for Undergraduate Education in Radiology: Large Bowel. DOI 10.26044/esr-undergraduate-ebook-03

Chapter: Large Bowel

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel





Chapter: Large Bowel

eBook for Undergraduate Education in Radiology

Based on the ESR Curriculum for Undergraduate Radiological Education

Chapter: Large Bowel

Authors

Anisha Bhagwanani

Vivienne Eze

Stuart Taylor

Affiliation

University College London



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Chapter Outline

- Radiological Anatomy
- Radiological Investigations

Acute Conditions

- Perforation
- Diverticulitis
- Epiploic Appendagitis
- Appendicitis
- Volvulus
- Intussusception

• Tumours

- Polyps
- Colorectal Cancer
- Appendix Tumours
- Lymphoma
- Secondary cancers

• Colitis

- Inflammatory bowel disease
- Ischaemic colitis
- Infectious colitis
- Radiation colitis
- Neutropenic colitis
- Acute fulminant colitis

• Functional Disorders of the Anorectum

- Constipation
- Difficulty initiating evacuation
- Sensation of incomplete evacuation
- Anal fistula
- Take-Home Messages
- References and Further Reading
- Test Your Knowledge

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Q

Anatomy

The **large bowel** is a muscular tube that is divided into the:

- caecum and appendix
- ascending colon
- hepatic flexure
- transverse colon
- splenic flexure
- descending colon
- sigmoid colon
- rectum
- anus



Chapter Outline

Radiological Anatomy
 Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Q

The peritoneum is a continuous membrane that lines the abdominal cavity and abdominal organs. It consists of two layers that are continuous with each other: the parietal and visceral peritoneum.

The parietal peritoneum lines the inner surface of the abdominopelvic wall. The visceral peritoneum covers the majority of the abdominal viscera.

The **peritoneal cavity** is a potential space between the parietal and visceral peritoneum.

Intraperitoneal organs are lined by visceral peritoneum both anteriorly and posteriorly. The caecum, appendix, transverse colon and sigmoid colon are intraperitoneal structures.

Retroperitoneal organs lie posterior to the peritoneum and are only covered only by peritoneum anteriorly – the ascending and descending colon are retroperitoneal structures and the rectum is extra-peritoneal.

Mesenteries are double layers of peritoneum which attach the intestine to the posterior abdominal wall and allows blood vessels, nerve and lymphatics to supply the intestine. The transverse and sigmoid colon have mesenteries called the transverse mesocolon and sigmoid mesocolon.



Figure 2. Schematic illustration of the peritoneum. Visceral peritoneum (green), parietal peritoneum (red). Main cavity (red texture), omental bursa (green texture).

Chapter Outline

- Radiological Anatomy
 Radiological Investigations
 Acute Conditions
 - Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel





Figure 3. Schematic illustration of the bowel wall layers

The layers of bowel wall are illustrated in the schematic diagram to the left.

The mucosa consists of epithelium, intestinal glands, the lamina propria and muscularis mucosa.

The **submucosa** consists of nerves, blood vessels and elastic fibers with collagen.

The muscularis propria consists of inner circular and outer longitudinal smooth muscle layers, with the myenteric (Auberbach) nerve plexus in between.

The outermost layer is the serosa. The serosa is a synonym for the visceral peritoneum and covers the intra-peritoneal transverse and sigmoid colon. The ascending and descending colon are retroperitoneal and the outer layer on their posterior surface is the adventitia.

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



The superior mesenteric artery supplies the colon proximal to the splenic flexure via the ileocolic, right and mid-colic branches. The distal colon is supplied by the inferior mesenteric artery via the left colic, sigmoid and superior rectal artery branches. The mid and inferior rectum are supplied via the internal iliac artery.

The marginal artery of Drummond is a vascular arcade running along the mesocolonic border formed by the terminal branches of the superior and inferior mesenteric arteries.



Figure 4. Coronal maximum intensity projection (MIP) image of a CT angiogram demonstrating the branches of the superior mesenteric artery.

Chapter Outline

Radiological Anatomy **Radiological Investigations Acute Conditions Tumours Colitis Functional Disorders of the Anorectum Take-Home Messages** References **Test Your Knowledge**

Chapter: Large Bowel



The veins follow the arteries with the right colon draining into the superior mesenteric vein and the left colon into the inferior mesenteric vein which drains into the portal vein, via the splenic vein. The middle and inferior rectal veins drain into the internal iliac vein.

The lymphatic drainage of the colon also follows the course of the arteries, draining ultimately into the coeliac nodes. From the proximal rectum, lymph drains superiorly via superior rectal artery nodes to the inferior mesenteric chain, posteriorly by nodes around the median sacral artery, and laterally around the middle rectal artery to the internal iliac chain.



Figure 5. Schematic illustration of the venous drainage of the large bowel

Chapter Outline

Radiological Anatomy
 Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



The rectum is defined as the distal 15cm of large bowel proximal to the anus. Anteriorly the rectum is covered by peritoneum to the level of the junction of the upper two-thirds and lower one-third.

The lateral and posterior aspects of the upper rectum and all the lower one-third are surrounded by the mesorectum, which is composed of loose adipose connective tissue containing the small perirectal lymph nodes and the superior rectal vessels. The mesorectum itself is enclosed by the mesorectal fascia. Posteriorly the mesorectal fascia is separated from the presacral fascia by the thin retrorectal space; anteriorly it blends with the rectovesical (Denonvillier) fascia; superiorly it is contiguous with the sigmoid mesentery; and inferiorly it terminates close to the anus in the parietal fascia covering the levator ani.



RECTUM

Figure 6. Schematic diagram of the male pelvis (left) and corresponding T2-weighted MRI image (right) in the axial plane

Chapter Outline

Radiological Anatomy **Radiological Investigations Acute Conditions Tumours Colitis**

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



The anus has a complex sphincter arrangement with an **internal sphincter** comprised of smooth muscle (a continuation of the circular muscle of the distal rectum) and an **external sphincter** of striated muscle. **Longitudinal muscle** lies between the internal and external sphincters, consisting of striated and smooth muscle with extensive fibroelastic tissue, which anchors the anus in position.



Figure 7. Schematic diagram of the anal sphincter anatomy (left) and corresponding STIR (fat-suppressed) MRI image (right) in the coronal plane

Chapter Outline

Radiological Anatomy **Radiological Investigations Acute Conditions Tumours Colitis Functional Disorders of the Anorectum Take-Home Messages** References **Test Your Knowledge**

Chapter: Large Bowel



The pelvic floor consists of muscle and connective tissue that forms a 'sling' across the base of the pelvis. It consists of three contiguous supporting layers – the endopelvic fascia, the muscular pelvic diaphragm and the urogenital diaphragm. These support the pelvic floor organs and assist in urinary and faecal continence. The muscular pelvic floor consists mainly of the levator ani complex along with the coccygeus and puborectalis muscles.





Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Figure 8. Schematic diagram of the female pelvic anatomy (left) and corresponding T2-weighted MRI image (right) in the sagittal plane



Chapter: Large Bowel



On **normal plain radiographs**, the large bowel tends to be peripheral whereas the small bowel tends to be central. The large bowel has a larger caliber than the small bowel.



Figure 9. Normal bowel gas pattern as seen on an abdominal plain radiograph. Most often gas shadows are not continuous. The course of the large bowel (red) and of the small bowel (blue) is shown on the annotated image. Case courtesy of Dr Jeremy Jones, Radiopaedia.org, rID: 34068

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel



Imaging Modalities

Plain radiographs are quick and easily accessible and they have a modest radiation dose. They have a <u>limited role</u> in colonic disease due to their low sensitivity and low specificity. However, plain radiographs may be used as a first-line investigation in the context of volvulus, bowel obstruction and toxic megacolon.

The standard projection is the anterior-posterior (AP) supine view. The posterior-anterior (PA) erect view is additionally used to assess free gas in the abdomen, as well as gas-fluid levels in suspected bowel obstruction.

Figure 10. Plain abdominal radiograph shows a volvulus of the sigmoid colon with a classic coffee-bean sign (blue outline). The apex of the volvulus points to the right upper quadrant and there are loops of dilated large bowel seen proximally (arrow). See for comparison Figure 9 (normal abdominal plain radiograph)



C

Chapter Outline

Radiological Anatomy

Radiological Investigations
 Plain Radiographs

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel



Cross-sectional imaging techniques consist mainly of computed tomography (CT), magnetic resonance imaging (MRI) and ultrasound (US). These have increasingly become the mainstay of colonic imaging.

In the emergency setting, CT is often the first line imaging test for assessing acute or life-threatening conditions such as bowel obstruction, bowel ischaemia, volvulus, intussception, the postoperative abdomen and the acute complications of inflammatory bowel disease for example (please see subsequent section on 'Acute Conditions').

A CT of the abdomen and pelvis with portal venous contrast (acquired at 60 seconds postintravenous contrast injection) is the standard imaging acquisition although this will vary according to the clinical question – for example, if bowel ischaemia is suspected, an arterial phase (at 30 seconds) will also be required to assess the arterial vessels for acute thrombus.



Chapter Outline

Radiological Anatomy

 Radiological Investigations
 Computed Tomography

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Figure 11. Coronal reformat of a portal venous phase CT abdomen/pelvis demonstrates acute large bowel obstruction secondary to a large prostatic mass (asterix) compressing on the distal colon (arrowhead). The large bowel should not measure more than 6cm (9cm at the caecum). The ascending colon on this image measures up to 7.5cm.

Chapter: Large Bowel

Q

Fluoroscopic contrast studies are less commonly performed today but remain useful for problem solving in complex cases e.g. for assessing postoperative intestinal integrity, diagnosing leaks and delineating colonic fistulae.

A water-soluble contrast enema uses a contrast agent such as diluted Gastrograffin, which is instilled into the rectum via a Foley catheter and allows real-time dynamic evaluation of colonic anatomy, using X-rays.

Double-contrast barium enemas are now obsolete tests and have been replaced by crosssectional imaging. They involved the use of bowel insufflation with either carbon dioxide or air for luminal distension and a smooth-muscle relaxant given intravenously. These were previously commonly used for the diagnosis of tumours and assessment of inflammatory bowel disease.



Figure 12. Single sagittal image from an iodinated contrast enema in a patient post anterior resection for a rectosigmoid tumour. There is a small volume leak from the posterior aspect of the lower anastomotic suture line.

Chapter Outline

Radiological Anatomy

 Radiological Investigations
 Fluoroscopic Contrast Studies

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



Computed tomography colonography (CTC) has replaced barium enema for the detection of colorectal cancer and polyps and refers to CT of the gas-filled colon. It is commonly performed in patients who are unsuitable for or have failed colonoscopy.

The patient is given a laxative preparation prior to the study and asked to drink an oral contrast agent to coat (or 'tag') any residual faecal contents remaining. CTC can be performed without laxative (with only a tagging agent) if required. Colonic distension is performed using carbon dioxide, typically via an automated insufflation device and is improved by the additional use of an intravenous anti-spasmodic agent e.g. hyoscine butylbromide. CT images are acquired in at least two views – prone and supine with additional decubitus images obtained if additional views are needed.

Interpretation is performed using a combination of 2D axial and multiplanar reconstructions and 3D reconstructions.

Intravenous contrast is also administered for evaluation of extra-colonic disease.





Figure 13. Prone axial CT reformat of a CTC showing C02 distended loops of bowel (white arrowhead) and 'tagged' faecal residue (white arrow).

Chapter Outline

Radiological Anatomy

Radiological Investigations
 CT Colonography

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Figure 14. 3D endoluminal reconstruction of the well-insufflated colon that has been cleansed with a laxative preparation.

Chapter: Large Bowel



Magnetic Resonance Imaging (MRI) remains the cross-sectional radiological technique of choice for pelvic imaging. It is accurate for local staging of rectal malignancy in addition to assessing benign disease such as anal fistulae and pelvic floor dysfunction.



Figure 15. Axial STIR (Short T1 Inversion recovery) sequence from a MR Fistula study showing the normal anatomy of the anal sphincters

MR Colonography (MRC) follows similar principles to CTC, requiring bowel cleansing and colonic distension. It can be used to evaluate the colonic lumen, colon wall and extra-luminal tissues. However, endoscopy remains the test of choice for evaluation of the colon in the assessment of inflammatory bowel disease. MRI with oral contrast, whilst mainly used to evaluate the small bowel, may have a role to play in evaluating colitis.

Chapter Outline

Radiological Anatomy

Radiological Investigations
 MRI

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Q

Evacuation proctography is a study of the dynamics of rectal evacuation. Conventionally the procedure has been performed using X-ray fluoroscopy, but MRI proctography is now more commonly used.

The rectum is distended using air or ultrasound jelly and evacuation is captured using a rapid dynamic MRI sequence.

Proctography may be viewed in three stages: Rest, evacuation and recovery. At rest, the anorectal junction is normally just above the plane of the ischial tuberosities. Evacuation is initiated by descent of the pelvic floor, widening of the anorectal angle, and relaxation of the anal sphincters.

During MRI proctography, organ prolapse is conventionally measured with respect to the **pubococcygeal line** which provides a convenient, reproducible point of reference.



Figure 16. Sagittal image from a MR defecating proctogram showing the rectum distended with jelly. The red line is the pubococcygeal line which is defined as the line that joins the inferior border of the pubic symphysis to the last coccygeal joint.

Chapter Outline

Radiological Anatomy

- Radiological Investigations
 Evacuation Proctography
 - **Acute Conditions**

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel



High frequency ultrasound provides detailed imaging of the colon wall and has a valuable role for assessing extent and activity of inflammatory bowel disease, the diagnosis of appendicitis and for assessment of the anal sphincters.



Figure 17. Ultrasound image demonstrating the alternating echogenicity of the different bowel wall layers:

1 Lumen/Superficial mucosa 2 Muscularis mucosa 3 Submucosa 4 Muscularis propria 5 Serosa LM PROBE LAS

Figure 18. Ultrasound image of the anal canal demonstrates the hypoechoic internal anal sphincter (IAS), the longitudinal muscle in the intersphincteric plane (LM) and the echogenic external anal sphincter (EAS).

Chapter Outline

Radiological Anatomy

- Radiological Investigations
 High Frequency Ultrasound
 - **Acute Conditions**

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel



А

PET (Positron emission tomography) is a nuclear medicine scan usually combined with CT (PET-CT) or MRI (PET-MRI) which has a role to play in the staging of metastatic or recurrent colon cancer. It uses an isotope tracer (18-fluoride) combined with a radiopharmaceutical (fluorodeoxyglucose) to highlight sites of metabolically active disease. They are useful for the assessment of extraluminal disease and distant metastases.

Colonic cancer and adenomatous polyps are often 18-FDG avid and may be found incidentally during PET scans performed for other indications.

В





Figure 19. A. Fused PET-CT image (left) showing a FDG avid rectal tumour (white arrow). There is radiotracer within the urinary bladder anteriorly due to excretion via the kidneys. B. MIP (maximum intensity projection) PET image on the right shows uptake in the rectum along with normal physiological uptake of tracer by the brain and myocardium, and excretion via the urinary bladder.

Chapter Outline

Radiological Anatomy

Radiological Investigations
 PET-CT

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Perforation

Colonic perforation is an acute surgical emergency. It may result from infection and inflammation, trauma including instrumentation, ischemia, malignancy, and bowel obstruction. Shown below are examples of colonic perforation.



Figure 20. Coronal CT image demonstrates an example of sigmoid colonic perforation with locules of gas outside the bowel (red arrows) secondary to the pressure effect of hard impacted faeces that forms a more solid mass (white arrow). This causes ischaemic necrosis of the colonic wall and ultimately perforation, known as stercoral perforation.



Figure 21. Axial CT image, taken in the portal venous phase, demonstrates a small perforation of the sigmoid colon with small locules of gas outside the bowel (red arrows) secondary to acute inflammation. There is also a small fluid collection (arrowhead) seen adjacent to the sigmoid colon. The patient had evidence of skip lesions (non-contiguous segments of inflamed bowel) and suspected undiagnosed Crohn's disease.



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions
 Perforation

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Chapter: Large Bowel

Diverticulitis

Diverticulae are out-pouchings of the muscular colonic wall. Diverticular disease denotes the presence of diverticulae, very commonly seen in elderly patients and most commonly in the sigmoid colon. Diverticulitis refers to the presence of inflammation, thought to be secondary to retention of faecal material in the diverticulum which leads to ischaemic necrosis and microperforation.

Differentiation of acute diverticulitis from a tumour can sometimes be difficult with overlapping imaging features. Cancer can present with a short segment of mass-like colonic mural thickening whilst diverticulitis often affects a longer segment of colon and is associated with mesenteric engorgement and fluid.

can cures.

Figure 22. CT is <u>the most accurate imaging modality</u> for the assessment of acute diverticulitis. Hallmark changes include colonic wall thickening (white arrow) and associated inflammatory change and oedema in the pericolic fat.



Chapter Outline

Large Bowel

Radiological Anatomy

Radiological Investigations

 Acute Conditions
 Diverticulae and Diverticulitis

Tumours

Chapter:

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel



<u>Complications of acute diverticulitis</u> include localised perforation, abscess and fistula formation. An abscess may perforate directly into the abdominal cavity causing faecal peritonitis. Rarely pseudocysts can form from expansion of a wall-off subserosal perforation. Abscesses less than 3cm are usually treated with antibiotics whilst those more than 4cm often benefit from image-guided drainage.



Fistula formation commonly involves the bladder resulting in a colovesical fistula. The fistulous tract may not always be seen but the presence of gas within the bladder (in the absence of catheterization or recent instrumentation) is highly suggestive.



Figure 23. Coronal (A and B) and axial (C) CT images showing a thick-walled gas-containing abscess (white arrow) in the pelvis as a result of severe acute diverticulitis. There is a direct fistulous tract (yellow arrow) between the urinary bladder and adjacent inflamed sigmoid colon with resulting dependent gas within the urinary bladder (asterix).

Chapter Outline

Radiological Anatomy

Radiological Investigations

 Acute Conditions
 Diverticulae and Diverticulitis

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Epiploic Appendagitis

Epiploic appendages are protrusions of subserosal fat, lined by peritoneum, that arise from the surface of the colon. There are around 50-100 of them in the colon, most commonly at the rectosigmoid junction.

Epiploic appendagitis is a self-limiting inflammatory/ischaemic process involving the appendix epiploica. The pathogenesis is thought to be due to torsion of a large pedunculated appendage or thrombosis of the venous outflow. Along with omental infarction, epiploic appendigitis falls under the broader group of intraperitoneal focal fat infarction.

The condition is self-limiting and is managed conservatively.



Figure 24. Axial CT image demonstrates a small rounded fatty nodule adjacent to the descending colon (white arrow). The lesion has a hyperdense capsule with surrounding inflammation (red arrow), consistent with epiploic appendigitis.

Chapter: Large Bowel



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions
 Epiploic appendagitis

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Appendicitis

This is the one of the most common abdominal pathologies. Imaging is used to support clinical evaluation to make the diagnosis, exclude other pathologies or to look for complications.

CT scans are very sensitive but care must be taken in younger patients given the associated radiation exposure. Ultrasound is a very useful alternative. Although highly specific, its sensitivity is limited. MRIs are also useful in pregnant women and paediatric populations.

On ultrasound, imaging findings are a dilated fluid-filled, non-compressible (>6mm), appendix with increased echogenicity of the surrounding fat suggesting peri-appendiceal inflammation. On colour Doppler images, there is increased vascularity of the appendix wall.







Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions Appendicitis

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

(longitudinal plane) of a dilated oedematous appendix (red arrow). Note the increased echogenicity of surrounding fat (yellow the arrows). The transverse diameter of the appendix measures 12.6mm. Increased vascularity demonstrated on colour Doppler assessment (transverse imaging plane).

В

Figure 25. A. Ultrasound image

Chapter: Large Bowel



<u>CT is superior to ultrasound</u> not only for the diagnosis of appendicitis but also for assessing for the presence of complications such as perforation or abscess formation. Low-dose CT has replaced standard CT in many institutions as it offers significant radiation dose reduction while having a similar diagnostic accuracy.



Figure 26. A and B. Axial and coronal CT images showing an inflamed appendix (white arrow) with inflammation of the surrounding fat (streaky, reticulated aspect). C. Coronal CT image in a different patient showing the inflamed appendix (white arrow), inflammation of the surrounding fat and abscess formation (red arrows)

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Appendicitis

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Volvulus

Volvulus is an uncommon cause of acute abdominal pain. It occurs when a segment of bowel twists arounds its own axis or around its mesentery. The sigmoid colon is the most common site of occurrence followed by the caecum. Volvulus can also occur (although less commonly) in the transverse colon and splenic flexure.

On an abdominal x-ray, findings are a **beanshaped** dilated loop of large bowel (see also Figure 10). CT demonstrates a "**whirl sign**" which denotes twisting of the mesenteric vessels. Complications include obstruction and perforation and these can be investigated on CT.

A volvulus is usually caused by a redundant segment of bowel (i.e. a very mobile segment of bowel not firmly attached to the mesentery). Occasionally, the cause of a volvulus is an obstructing lesion and as such in patients with intermittent episodes of volvulus, colonoscopy or CT colonography (CTC) should be done afterwards to exclude a tumour.





Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Volvulus

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Figure 27. CT topogram (A) and axial CT image (B) showing the characteristic aspect of a sigmoid volvulus. The large dilated loop of the sigmoid colon (red asterisk) has a wall without haustra and the lower end points towards the pelvis. There is no rectal gas (white asterisk). The liver overlap sign can be seen, i.e. the sigmoid volvulus ascends to the right upper quadrant and projects over the liver (green asterisk). There is major large bowel dilatation due to to obstruction. Case courtesy: Pierre Alexandre Poletti, MD, Geneva University Hospitals.

Intussusception

This is when one segment of bowel telescopes into another segment of bowel. The segment of bowel on the outside is called the *intussusceptum* and the bowel that telescopes into it is called the *intussuscipiens*.

Intusussception is more common in children and often occurs and resolves intermittently. It can sometimes get stuck, leading to oedema and subsequently obstruction of the intussusceptum. Timely reduction to avoid bowel necrosis is essential.

In adults, colonic intussusception is almost always due to a tumour, which serves a lead point.

Ultrasound is very useful for diagnosis in children however in adults, CT is preferable. Imaging shows a typical "target" appearance.



Figure 28. Ultrasound scan in a case of ileo-colic intussusception showing a target appearance of bowel within bowel. This appearance is caused by alternating concentric hypoechoic and hyperechoic bands. The hyperechoic bands correspond to the mucosa and muscularis, whereas the hypoechoic bands correspond to the submucosa.



Chapter Outline

Large Bowel

Radiological Anatomy

Radiological Investigations

Acute Conditions
 Intussusception

Tumours

Chapter:

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Tumours - Polyps



Chapter Outline Radiological Anatomy Radiological Investigations Acute Conditions

TumoursPolyps

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Polyps are elevated mucosal lesions which can be classified according to their morphology (Paris classification) or histological types.

The most clinically significant polyps are adenomas which have the potential to become dysplastic and develop into a cancer. Adenomas can be histologically classified as tubular, villous or tubulovillous. Villous adenomas are more likely to become malignant. Other risk factors are adenomas > 1cm in size or those containing high grade dysplasia.

Benign histological subtypes include hamartomatous and inflammatory polyps.

The detection of polyps is therefore important to remove or reduce the risk of developing colorectal cancer. Endoscopy and CT colonography form the mainstay of polyp detection.

Figure 29. 2D image from a CTC (A) and 3D reconstruction (B) of a rectal polyp (white arrows). Note the rectal catheter used for CO2 insufflation seen directly adjacent to the polyp.





Chapter: Large Bowel

The morphology of polyps can be described according to the Paris classification.

Pedunculated polyps (Paris Ip) have a stalk and are more likely to contain high-grade dysplasia. However, because the stalk provides distance between the polyp and bowel wall, they are often considered cured once resected.

Sessile polyps (Paris Is) have a broad base and a higher risk of invasive malignancy.

Subpedunculated polyps (Paris Isp) are intermediate in risk and appearance between pedunculated and sessile polyps.

Flat lesions (Paris 0-II group) is defined as being less than 3mm in height above the mucosal surface.

Paris 0-IIa are slightly elevated, Paris 0-IIb are completely flat and Paris 0-IIc are depressed rather relative to the mucosal surface. The latter have a higher risk of invasive cancer.



Figure 30. Schematic illustration of the Paris classification.



Chapter Outline

Radiological Anatomy Radiological Investigations

Acute Conditions

TumoursPolyps

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



Chapter Outline

- Radiological Anatomy Radiological Investigations Acute Conditions
- TumoursPolyps

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge



Figure 31. Case example of a 3D endoluminal reconstruction (A) which demonstrates two polyps in the sigmoid colon (white arrows). The larger polyp of the two is also demonstrated on the 2D axial CTC image (B) which shows a predominantly raised flat polyp (Paris IIa).

Chapter: Large Bowel

There are a number of <u>inherited polyposis syndromes</u> which carry an increased risk of developing colorectal cancer (CRC).



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

 Tumours
 Inherited Polyposis Syndromes

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Familial Adenomatous Polyposis (FAP)

- Autosomal Dominant inheritance
- Typically, have >100 adenomatous polyps
- All patients eventually develop CRC
- Preventative proctocolectomy is therefore recommended
- Extra-intestinal manifestations include skull osteomas, abnormal dentition and desmoid tumours
- Gardner syndrome is a variant of FAP with prominent skeletal and skin manifestations

Hereditary Non-polyposis colorectal cancer (HNPCC)

- Autosomal dominant inheritance
- Increased risk of endometrial, small bowel and transitional cell carcinoma
- 70% of colorectal cancers occur in the proximal colon

Peutz-Jeghers syndrome

- Autosomal dominant inheritance
- Small bowel hamartomas. Large bowel polyps are less common
- Mucocutaneous pigmentation

Turcot syndrome

- Rare polyposis syndrome
- Colonic adenomatous polyps and CNS tumours e.g., medulloblastomas

Cowden syndrome

- Hamartomatous polyps
- Mucocutaneous lesions, thyroid abnormalities, fibrocystic disease of the breast

Cronkhite-Canada syndrome

- Multiple or large serrated colonic polyps
- Alopecia, nail atrophy and skin hyperpigmentation

Chapter: Large Bowel

Patients with Familial Adenomatous Polyposis (FAP) are at risk of developing extra-colonic adenomas, particularly in the stomach and duodenum. In addition, desmoid tumours (benign locally infiltrative fibroblastic tumours) have a known association with FAP. The development of desmoid tumors is often precipitated by trauma or surgery.



Figure 32. Case example of a patient with known FAP and previous colectomy. There is an end-ileostomy with an

incidental para-stomal hernia (dashed arrow in A). The patient developed a desmoid tumour in the small bowel mesentery (star) with associated retraction and nodularity

of the mesentery (arrow in B) and tethering of the small

bowel. A number of years later, the same patient went on

to develop a mass at the junction of the second and third parts of the duodenum (arrows in C and D) which was

confirmed to be avid on FDG-PET CT (D and E), highly suspicious for the development of an adenocarcinoma. Normal FDG uptake is also demonstrated in the kidneys

(asterisks in D, dashed arrows in E).

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

 Tumours
 Inherited Polyposis Syndromes

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References




Chapter: Large Bowel

Tumours – Colorectal cancer (CRC)



Primary colorectal cancer is the second most common cause of cancer mortality in both men and women in Europe. 5-year survival is around 50%.

Over half of cases occur in the sigmoid and rectum, with one third alone occurring in the rectum.

Prognostic factors include local tumour invasion, vascular or lymphatic involvement, preoperative elevation of carcinoembryonic antigen (CEA) and tumour differentiation.

The traditional **Duke's staging system** has been largely **replaced by the TNM** (tumour, nodes, metastases) system.

CT estimates the T stage but is less able to distinguish between early T stages (T1 and T2). Ultrasound is better than CT at differentiating between T1 and T2 tumours. MRI is used to locally stage rectal cancers.

Adverse prognostic factors are T3 or T4 tumours, and tumours with extra-mural venous invasion which is suspected by the expansion of draining veins.

Poor-prognostic rectal tumours are likely to receive neoadjuvant chemotherapy prior to surgical resection.

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours
Colorectal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

TNM	Tumour Extent		Dukes
Stage I	Invasion into submucosa T1		A
	Invasion into muscularis propria T2		
Stage II	Invasion outside muscularis propria T3		В
	Invasion of visceral peritoneum T4a		
	Invasion of other organs T4b		
Stage III	1-3 lymph nodes involved N1		С
	≥ 4 lymph nodes N2		
Stage IV	Distant metastasis in one organ M1a		D
	Distant metastasis in > 1 organ or to the peritoneum M1b		
	Peritoneal metastases M1c		
			/
		SUB	MUCOSA /



ORGAN

MESORECTAL

FASCIA

PERITONEAL REFLECTION

LUMEN

MESORECTUM

T4b

T4a

MUSCULARIS PROPRIA-

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours
Colorectal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Figure 33. 8th Edition TNM staging of colorectal cancer (CRC)

Chapter: Large Bowel

CTC has an equivalent sensitivity to colonoscopy for detecting CRC and readily depicts colonic masses. On conventional CT, tumours are seen as a focal area of wall thickening. Conventional CT has a modest sensitivity for colon cancer compared to CTC with bowel cleansing and colonic distension. Nodal staging accuracy is also modest on cross-sectional imaging.



Chapter Outline

Radiological Anatomy Radiological Investigations

Acute Conditions

Tumours
Colorectal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge





Figure 33. The axial CTC image (A) demonstrates a circumferential mass at the hepatic flexure (pink arrow) which is causing luminal narrowing. Compare this with the remainder of the colon which has a paper-thin wall (turquoise arrow). The coronal CT image (B) demonstrates thickening of the caecum (pink arrow), which proved to be an adenocarcinoma on biopsy taken at the time of colonoscopy. There is also evidence of tumour extension into the pericolic fat (turquoise arrow) and multiple adjacent regional lymph nodes (red arrows). The T and N staging is therefore T4a N2.

Chapter: Large Bowel



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours
Colorectal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

MRI is imaging investigation of choice for the local staging of rectal cancer.

The surgical treatment of rectal cancer involves a total mesorectal excision (TME) which is a total resection of the tumour, rectum and mesorectum. The dissection plane along the mesorectal fascia is known as the circumferential resection margin (CRM).

The CRM is considered positive if there is tumour within 1mm of the CRM or 'threatened' if within 1-2mm of the margin. These tumours will require down-staging with neoadjuvant chemoradiotherapy prior to surgery to increase the likelihood of curative surgery.

Local nodes and extra-mural vascular invasion can also be assessed on MRI. Morphological features such as an irregular contour and heterogeneous signal intensity of lymph nodes confer a high likelihood of disease involvement.

Chapter: Large Bowel





Figure 34. Pelvic CT (A) shows a semiannular tumour within the mid-rectum which has rolled edges (pink arrow). The same lesion is shown on a small-field of view axial MRI sequence (B). There is clear evidence of tumour extension beyond the muscularis propria (dark black outline) and into the perirectal fat (arrowhead). On C, the tumour extends from the 10 - 6 o'clock position. There are small lymph nodes (turquoise arrows). The more anterior of these lie approximately 1mm from the circumferential resection margin (orange arrow). The mid-rectal tumour as seen on the sagittal MRI sequence (D).

Chapter Outline

Radiological Anatomy Radiological Investigations

Acute Conditions

Tumours
Colorectal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



Chapter Outline

Radiological Anatomy Radiological Investigations Acute Conditions

Tumours
Colorectal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

MRI also has an important role to play in the evaluation of tumour response after chemoradiotherapy. Diffusionweighted sequences may be helpful for assessing if there is any residual tumour present. The presence of a dense fibrotic scar with no evidence of tumour signal denotes a complete radiological response. In some centers, such patients may undergo close 'watch and wait' surveillance rather than straight to surgery.



Figure 35. Axial MRI shows a bulky tumour in the anterior lower rectum (A, **orange arrows**) infiltrating into the vagina on the left. The corresponding DWI sequence (B) shows high signal consistent with the presence of restricted diffusion. MRI following chemoradiotherapy (C) shows a very good response to treatment. The bulky mass has been replaced with low signal fibrosis (**turquoise** arrows). On the corresponding DWI images, there was no associated residual high signal (not shown).



Chapter: Large Bowel

Anal cancers are relatively uncommon and account for less than 2% of large bowel malignancies. They are defined as originating between the anorectal junction above and the anal verge below. MRI is the modality of choice for staging anal cancers.



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

TumoursAnal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

The majority are squamous cell cancers and have a high association with HPV (human papilloma virus).



They are staged differently to rectal tumours as follows:

TNM	Tumour Extent		
Stage I	Tumour 2cm or less in greatest dimension T1		
Stage IIa	Tumour >2cm but <5cm in greatest dimension T2		
Stage IIb	Tumour >5cm in greatest dimension T3		
Stage IIIa	T1 or T2		
	Metastases in inguinal, mesorectal and/or internal iliac lymph nodes N1a		
	Metastases in external iliac lymph nodes N1b		
	Metastases in external iliac and N1a nodes N1c		
Stage IIIb	Tumour of any size that invades adjacent organs T4		
Stage IIIc	T3 + N1 + M0 (no distant metastases)		
Stage IV	Any T stage + Any N stage + M1 (distant metastases)		

Chapter: Large Bowel





Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours Anal Cancer

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Tumours - Appendix

There are a number of neoplasms which can involve the appendix, most commonly <u>neuroendocrine tumours or</u> <u>mucinous neoplasms</u>. Mucinous neoplasms of the appendix range from more benign mucoceles to more malignant cystadenocarcinomas. They are the most common cause of pseudomyxoma peritonei which is the intraperitoneal accumulation of mucinous ascites related to a mucin-producing neoplasm.



Figure 37. Coronal CT reformat demonstrates a cystic tubular mass arising from the caecum (asterisk). No soft tissue component to the mass. Histology post surgical resection confirmed a low grade appendiceal mucinous neoplasm.



Chapter Outline

Radiological Anatomy Radiological Investigations Acute Conditions

TumoursAppendix Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Tumours - Lymphoma

Q

Chapter Outline

Radiological Anatomy Radiological Investigations Acute Conditions

TumoursLymphoma

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Lymphoma of the large bowel is uncommon. There will often be marked bowel wall thickening or aneurysmal dilatation without obstruction.





Figure 38. Coronal CT reformat (A) demonstrates a large intraluminal mass within the caecum (star). Biopsy confirmed this to be mantle cell lymphoma with involvement of the caecum. CT also demonstrates bulky mesenteric (pink arrow) and inguinal lymphadenopathy (turquoise arrows). Fused images (B) and planar 2D image (C) from PET-CT show uptake of the FDG tracer at the site of the caecum, consistent with lymphoma (orange arrow and circle).



Chapter: Large Bowel





Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

TumoursLymphoma

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

Figure 39. The same patient as in Figure 38 went on to develop ileocolic intussusception <u>secondary to the lymphoma mass acting as a</u> <u>lead point</u>. Intussusception is where the bowel invaginates on itself and is pulled into a neighbouring loop of bowel (see Acute conditions). The intussusceptum is in this case the terminal ileum (turquoise arrow) and the intussuscipiens is in this case the caecum, (pink arrow). As on the previous CT (Figure 38), there is evidence of widespread bulky lymphadenopathy (orange arrows).

Chapter: Large Bowel

Tumours - Secondary Cancers

The colon may be secondarily involved by direct invasion, lymphatic permeation, intraperitoneal seeding or haematogenous spread. Gastric cancer spreading via the gastrocolic ligament or pancreatic cancer spreading via the transverse mesocolon are typical.

Serosal tumour spread can cause tethering and contraction of the bowel wall secondary to a desmoplastic response. Occasionally, haematological spread may produce a more diffuse 'linitis plastica' appearance.

Figure 40. Axial CT slices from the same patient show serosally-based nodules (arrows) in the rectosigmoid colon (A) and mid-

Figure 40. Axial CT slices from the same patient show serosally-based nodules (arrows) in the rectosigmoid colon (A) and midproximal sigmoid colon (B) in a patient with a history of previously treated ovarian cancer. The metastatic lesions are consistent with recurrence of the patient's cancer.



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

TumoursSecondary Cancers

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Colitis

Colitis refers to inflammation of the large bowel. It can occur as a result of infection, inflammation and some sometimes, ischaemia. Colitis is often evaluated using cross sectional imaging, primarily CT and MRI. Ultrasound can be used particularly in patients with inflammatory bowel disease who require regular imaging. Given the multiple potential causes, imaging features can be non-specific.

The main diagnostic criteria for colitis is a wall thickness of >4mm. Depending on the cause, other signs may be present such as:

- Distension
- Increased or decreased enhancement
- Changes in the surrounding fat- "fat stranding"

Figure 41. Coronal CT showing in a patient with colitis showing gross oedema and thickening of the bowel wall measuring approximately 10mm (**orange star**), increased mucosal and serosal enhancement and mild surrounding fat stranding (**orange arrow**).





Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Cause of Colitis and Common Sites of Involvement



Chapter Outline

Radiological Anatomy

Large Bowel

Chapter:

Radiological Investigations RIGHT-SIDED DIFFUSE **LEFT-SIDED Acute Conditions Tumours** • Cytomeglovirus • Tuberculosis Ischaemic (watershed) • Pseudomembranous • Crohn's • Shigella **Colitis** Causes and Sites of colitis Gonorrhoea Salmonella Involvement • Ulcerative colitis • Neutropenic colitis • Ulcerative colitis **Functional Disorders of the** • Ischaemic colitis (hypo- Radiation colitis Anorectum perfusional) **Take-Home Messages** References **Test Your Knowledge**



Chapter: Large Bowel

Inflammatory Bowel Disease

This is a term used to denote two main conditions- Ulcerative Colitis and Crohn's Disease.

Ulcerative disease affects <u>only</u> the colon and <u>rectum</u> (the small bowel is <u>not</u> involved). Inflammation is <u>confined to</u> the <u>mucosa</u> and usually starts at the rectum and progresses proximally to include the rest of the colon in a continuous manner.





Figure 42. Coronal heavily T2 –weighted sequences (A, B, C) in a patient with long standing colonic inflammatory bowel disease. Notice the lack of normal colonic haustra (lead-pipe appearance) in the transverse (orange star), descending (turquoise star) and sigmoid colon (pink star) and thickening of the descending colon.



Chapter Outline

Radiological Anatomy Radiological Investigations

Acute Conditions

Tumours

ColitisUlcerative Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Crohn's disease on the other hand can affect both small and large bowel, rectum and anus. The most common site of disease is the terminal ileum. The inflammation in Crohn's is not continuous, and there can be segments of normal bowel interspersed between areas of inflammation. In addition, unlike ulcerative colitis, Crohn's disease affects all the bowel layers (i.e. it is transmural) and can therefore, lead to perforation, fistulation and abscess formation.



Figure 43. Coronal CT scan (A) showing right sided colitis (orange arrows) in a patient with Crohn's disease with involvement of the ileo-caecal junction (pink arrows). Sagittal CT scan (B) of the same case demonstrating normal bowel (orange square) between affected segments and pseudo-sacculation (turquoise arrow) due to stricturing.



Both diseases have overlapping

presentations with abdominal pain, weight loss and diarrhoea (bloody

diarrhoea in ulcerative colitis)

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

ColitisCrohn's Disease

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel



Figure 44. Ultrasound showing a thickened sigmoid colon (6.1mm in A) with increased vascularity on colour Doppler assessment (B) in a case with left-sided colonic Crohn's disease. MRI scan of the same patient with axial T2 TRUFFI and HASTE fat saturated sequences (C and D) showing an inflamed thickened sigmoid colon with a narrowed lumen (pink arrows).

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

ColitisCrohn's Disease

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Ischaemic Colitis

This occurs when there is an absence or reduction in blood flow to the colon. It is mainly seen in people >60 years

but is sometimes present in younger patients with hypercoagulable states, vasculitis, long distance athletes and in



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis Ischaemic Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

cases of drug use. It is a life-threatening condition and may require urgent surgical intervention, although many cases resolve spontaneously. ٠

Figure 45. Coronal (A) and sagittal (B) slices of a patient with suspected ischaemic colitis affecting the splenic flexure and proximal descending colon. Note uniform and segmental bowel wall thickening with a low density linear band (submucosal oedema) between enhancing mucosa and serosa.

The causes include

- Arterial or venous occlusion
- Low flow states/hypoperfusion
- Increased intracolonic pressure proximal to an area of obstruction



The splenic flexure is mostly affected (Figure 45) as it is a watershed area, i.e., lies between the superior mesenteric artery (SMA) and inferior mesenteric artery (IMA) vascular territories).

Venous ischaemia tends to present with more wall thickening than is seen in arterial ischaemia.

The degree of wall thickening does not correspond to the degree of transmural necrosis.

Chapter: Large Bowel

On plain radiographs, signs include thumbprinting (which indicates mural oedema), pneumoperitoneum (indicating perforation) and gas in the portal venous system (indicating transmural necrosis). These are also seen on CT and effort should be made to look for would be sites arterial or venous occlusion.



Chapter Outline

Radiological Anatomy Radiological Investigations Acute Conditions

Tumours

ColitisIschaemic Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge



Figure 46. Coronal (A) and axial CT images (B) of a patient with ischaemic colitis affecting the descending colon and sigmoid (IMA territory). Signs are bowel wall thickening and surrounding fat stranding (pink arrows). Note for comparison normal fat aspect without stranding (green arrow).

Chapter: Large Bowel

Infectious Colitis Pseudomembranous Colitis



Figure 47. Axial (A) and coronal CT (B) images showing inflammation

of the sigmoid colon (**pink arrow**) and the a caecum (**orange arrow**) in a case of confirmed C-Difficile

infection

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis
Infectious Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

This is a form of infectious colitis caused by an overgrowth of *Clostridium Difficile* bacteria, often as a result of broad spectrum antibiotic use. It usually presents with fever, diarrhoea and a raised white cell count. It can progress to a fulminant colitis which is characterized by necrosis and perforation and as such, can be a surgical emergency.

On CT MRI and US, there is marked bowel wall thickening, with submucosal hyperenhancement and submucosal oedema.



Chapter: Large Bowel

Tuberculosis



This is another common infectious cause of colitis and should be considered in patients from areas where tuberculosis (TB) is endemic.



Figure 48. Coronal CT images of TB colitis affecting the right colon (orange arrows). Note the presence of associated enlarged mesenteric nodes (dotted circle)

It can affect any part of the bowel but is mostly seen in the terminal ileum and ileo-caecal region. When it affects the ileo-caecal region, it may be difficult to differentiate it from Crohn's disease.



Differentiating features include:

- Ascites
- Gross lymphadenopathy (particularly lymphadenopathy with caseous necrosis)
- Peritoneal involvement
- Conical contracted appearance of the caecum with a dilated terminal ileum.

Chapter Outline

- **Radiological Anatomy**
- **Radiological Investigations**
- **Acute Conditions**
- Tumours
- ColitisInfectious Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Chapter: Large Bowel



Other organisms are also known to cause colonic inflammation including Salmonella, shigella, and cytomegalovirus (CMV).



Shigella causes mainly left-sided colitis and Salmonella mainly right-sided colitis. Left-sided colitis is also seen in patients with gonorrhoea. CMV causes a vasculitis leading to diffuse colonic inflammation with associated mesenteric lymphadenopathy and sometimes, ascites.



Figure 49. Coronal CT showing right-sided colitis (orange arrow) and enteritis affecting the distal and terminal ileum (turquoise arrows) in a case of confirmed Shigella infection.

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis
Infectious Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Radiation Colitis

Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis Other Causes

> **Functional Disorders of the** Anorectum **Take-Home Messages**

References

Test Your Knowledge

This refers to inflammation as a result of previous radiation therapy. It is a late complication (often years after treatment) that can occur due to either direct radiation treatment (for example in patients with rectal cancer), or from radiation therapy to adjacent organs (such as the prostate and gynaecological organs).

Exposure to radiation above 45Gy leads to inflammation of the end arteries resulting in ischaemia, inflammation, and subsequently fibrosis and stricture formation. In some cases, there may be fistulation with adjacent structures such as the bladder or the vagina. The rectum is most commonly involved.



On imaging, findings are bowel wall thickening, mesenteric fat stranding and widening of the pre-sacral space, and thickening of the mesorectal fascia.

Figure 50. Axial CT showing a thickened inflamed rectum (proctitis) post radiotherapy treatment for prostate cancer (orange arrow).



Neutropenic Colitis

This is a specific form of colonic inflammation seen in **immunosuppressed** individuals with **neutropenia**.

As with other causes of colitis, imaging findings are wall thickening and oedema (although less than seen in other infectious colitis) and signs of adjacent mesenteric inflammation (stranding).

The inflammation usually affects the right colon but can be confined to the caecum – a condition known as <u>typhlitis</u>.



Chapter Outline

Large Bowel

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Chapter:

ColitisOther Causes

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Acute Fulminant Colitis



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

ColitisOther Causes

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

This is a late complication of colitis characterized by transmural inflammation and neuromuscular degeneration leading to gross colonic dilatation- <u>toxic megacolon</u>- and potentially, perforation.

The hallmark of fulminant colitis is a dilated colon(>5cm) with absence of normal colonic haustra. Fulminant colitis can be with all causes of colonic inflammation but is most commonly seen in cases of ulcerative colitis.

Abdominal x-rays are useful in assessing for colonic dilatation and particularly for monitoring. In the supine position, the transverse colon is the easiest site to observe findings as it is the least dependent part of the colon.

Chapter: Large Bowel

Functional Disorders Of The Anorectum



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Test Your Knowledge

These include **constipation**, **difficulty initiating defaecation**, to the **feeling of incomplete emptying**, and needing rectal digitation to facilitate evacuation.

CONSTIPATION

This is a common presenting complaint and is usually as a result of slow transit of food. To assess colonic transit, several radiopaque markers with different shapes are ingested; 20 markers on day 1, 20 on day 2 and 20 on day 3. An abdominal radiograph is then obtained on Day 5 to evaluate the position of the markers. The presence of >4 of day 1 markers, >5 of day 2 markers and >12 of day 3 markers is considered abnormal.

DYSSYNERGIA (Anismus)

A functional inability to empty the rectum. Diagnosis can be made radiologically by fluoroscopic or MR defaecating proctograms.



Findings include:

- Delayed or incomplete evacuation (<66% of the instilled rectal contents in 30 seconds)
- Failure of the pelvic floor and anal sphincter to relax on straining
- Co-existing anatomical findings are not infrequent
 - Anterior bulging of the rectal wall with retention within the rectocoele
 - Ancillary findings such as sigmoidocoeles/peritoneocoeles



Chapter: Large Bowel

Difficulty Initiating Evacuation

This is due to dyssynergia between straining and relaxation of the of the anorectal junction and is termed anismus.



Turquoise star = rectum with instilled gel Pink star = Bladder White star = Vagina Orange star= Anorectal junction

On straining, there is no evacuation despite relaxation of the pelvic floor evidenced by the descent of the bladder and anorectal junction

On maximum straining, there is still no evacuation of the rectal contents. This is a case of anismus. Note the anterior bulging of the rectal wall indicating a rectocoele (purple arrow). The purple star denotes the anorectal junction



Chapter Outline

Radiological Anatomy Radiological Investigations Acute Conditions Tumours Colitis

 Functional Disorders of the Anorectum
Difficulty Initiating Evacuation

Take-Home Messages

References

Test Your Knowledge

Figure 51. MR defaecating proctogram (A-C).

Chapter: Large Bowel

Incomplete Emptying

The feeling of incomplete emptying can be due to **rectocoeles** (bulging of the anterior wall of the rectum leading to pressure sensation and sometimes, faecal trapping) and **rectal intussusception**. Rectocoeles are often seen in multiparous women but are not always symptomatic.



Figure 52. MR proctogram showing a rectocoele (**pink arrow**) and early rectal intussusception (**turquoise arrow**).



Figure 53. MR proctogram showing an obstructive rectal intussusception preventing complete evacuation. Note the narrowing of the rectum due to intussusception (**orange arrow**).



Chapter Outline

- Radiological Anatomy
- **Radiological Investigations**
- **Acute Conditions**

Tumours

Colitis

 Functional Disorders of the Anorectum
Incomplete Emptying

Take-Home Messages

References

Chapter: Large Bowel

Anal Fistula



Chapter Outline

This is an abnormal connection between the anal canal and the perineal skin surface via a tract. These commonly occur as a result of cryptoglandular inflammation, or Crohn's disease. They are often is divided into 4 types according to the Parks classification; intersphincteric, transphincteric, suprasphincteric and extrasphincteric.



Figure 54. Coronal (A) and axial (B) MRI slices showing a perianal abscess (**pink arrows**) as a result of an anal fistula in Crohn's disease involving the puborectalis muscle.



MRI is the modality of choice for investigating anal fistulae. T2 and STIR sequences show as high signal against the low signal of the sphincter complex and adjacent fat (on the fat supressed sequences). Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

 Functional Disorders of the Anorectum
Anal Fistula

Take-Home Messages

References

Chapter: Large Bowel

Take-Home Messages

- Cross-sectional imaging forms the mainstay for the imaging of colonic pathologies.
- Abdominal radiographs have a role to play in specific situations, namely in suspected volvulus, bowel obstruction or toxic megacolon.
- CT is the first-line imaging modality in acute or life-threatening conditions.
- Ultrasound has a role to play in the assessment of acute appendicitis and inflammatory bowel disease.
- MRI is mainly used for assessment of pelvic disease, namely primary staging of rectal and anal cancers, functional disorders of the anorectum and the imaging of perianal fistulas.



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

References and Further reading

- Boone D, Plumb A, Taylor SA (2021). '*The Large Bowel*' in Dixon A.K. (ed.) *Grainger & Allison's Diagnostic Radiology: A Textbook of Medical Imaging 7*th *Ed.* Elsevier Limited, p. 568-597.
- Jaffe T, Thompson WM. Large Bowel Obstruction in the Adult: Classic Radiographic and CT Findings, Etiology and Mimics. Radiology 2015; 275(3): 651–63.
- Maturen KE, Wasnik AP, Kamaya A, Dillman JR, Kaza RK, Pandya A, Maheshwary RK. *Ultrasound Imaging of Bowel Pathology: Technique and Keys to Diagnosis in the Acute Abdomen.* American Journal of Roentgenology 2011;197: 1067-75.
- Gore R, Smithuis R. *CT Pattern of Bowel Wall Thickening*. 2014. <u>https://radiologyassistant.nl/abdomen/bowel/bowel-wall-thickening-ct-pattern</u>
- Burbridge B, Mah E (n.d.) *Approach to the Abdominal X-ray* in *Undergraduate Imaging Diagnostic Fundamentals.* PressBooks. <u>https://undergradimaging.pressbooks.com/chapter/approach-to-the-abdominal-x-ray-axr</u>
- Frickenstein AN, Jones MA, Behkam B, McNally LR. *Imaging Inflammation and Infection of the Gastrointestinal Tract.* Int. J. Mol. Sci. 2020; 21, 243



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



1 – What is the upper limit for the diameter of a normal appendix?

- 3mm
- 4mm
- 5mm
- 6mm
- 7mm



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



1 – What is the upper limit for the diameter of a normal appendix?

- 3mm
- 4mm
- 5mm



• 7mm



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



Q

Chapter: eBook for Undergraduate Education in Radiology Large Bowel **Chapter Outline Test Your Knowledge Radiological Anatomy Radiological Investigations** 2 – How many layers does the bowel wall have on high resolution ultrasound? **Acute Conditions Tumours** 3 **Colitis Functional Disorders of the Anorectum** 5 **Take-Home Messages** References 6 Test Your Knowledge



Chapter: Large Bowel

Test Your Knowledge



3 – Which sign is used to describe the appearance of sigmoid volvulus on an abdominal radiograph?

- Lead-pipe sign
- Comb's sign
- Target sign
- Coffee-bean sign
- Accordion sign



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References
Chapter: Large Bowel

Test Your Knowledge



3 – Which sign is used to describe the appearance of sigmoid volvulus on an abdominal radiograph?

- Lead-pipe sign
- Comb's sign
- Target sign
- ✓ <u>Coffee-bean sign</u>
- Accordion sign



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



4 – Which is the optimal imaging modality for the detection of colonic tumours and polyps?

- Abdominal radiograph
- CT colonography
- Portal-venous phase CT
- MR abdomen and pelvis
- PET-CT



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



4 – Which is the optimal imaging modality for the detection of colonic tumours and polyps?

- Abdominal radiograph
- ✓ <u>CT colonography</u>
- Portal-venous phase CT
- MR abdomen and pelvis
- PET-CT



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



- 5 Which of the following are included in the imaging protocol for CT colonography?
- Intravenous contrast
- Faecal tagging
- Laxative preparation
- Anti-spasmolytic
- Two or more patient positions



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



5 – Which of the following are included in the imaging protocol for CT colonography?

✓ Intravenous contrast

- ✓ <u>Faecal tagging</u>
- ✓ <u>Laxative preparation</u>
- ✓ <u>Anti-spasmolytic</u>
- ✓ <u>Two or more patient positions</u>



Chapter Outline

- **Radiological Anatomy**
- **Radiological Investigations**
- **Acute Conditions**
- Tumours
- Colitis
- Functional Disorders of the Anorectum
- **Take-Home Messages**
- References
- Test Your Knowledge

Chapter: Large Bowel

Test Your Knowledge



6 – What is the gold-standard test for the local staging of rectal cancer?

- Colonoscopy
- Portal-venous phase CT
- Endoanal ultrasound
- PET-CT
- Rectal MRI



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



6 – What is the gold-standard test for the local staging of rectal cancer?

- Colonoscopy
- Portal-venous phase CT
- Endoanal ultrasound
- PET-CT





Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



7 – In the context of rectal cancer, the circumferential resection margin (CRM) is considered involved on MRI if there is disease within what distance?

- 1mm
- 2mm
- 3mm
- 4mm
- 5mm



Chapter Outline

- **Radiological Anatomy**
- **Radiological Investigations**
- **Acute Conditions**
- **Tumours**
- Colitis
- Functional Disorders of the Anorectum
- **Take-Home Messages**
- References
- Test Your Knowledge

Chapter: Large Bowel

Test Your Knowledge



7 – In the context of rectal cancer, the circumferential resection margin (CRM) is considered involved on MRI if there is disease within what distance?



- 2mm
- 3mm
- 4mm
- 5mm



Chapter Outline

- **Radiological Anatomy**
- **Radiological Investigations**
- **Acute Conditions**
- **Tumours**

Colitis

- Functional Disorders of the Anorectum
- **Take-Home Messages**
- References
- Test Your Knowledge

Chapter: Large Bowel

Test Your Knowledge



- 8 Familial adenomatous polyposis is one of the most common inherited polyposis syndromes. What is its inheritance pattern?
- Autosomal dominant
- Autosomal recessive
- X-lined dominant
- X-lined recessive
- Mitochondrial



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



8 – Familial adenomatous polyposis is one of the most common inherited polyposis syndromes. What is its inheritance pattern?

✓ <u>Autosomal dominant</u>

- Autosomal recessive
- X-lined dominant
- X-lined recessive
- Mitochondrial



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



- 9 Which of the following statements is INCORRECT?
- Ischaemic colitis most commonly involves the watershed territories.
- CT is the first-line imaging modality for the assessment of ischaemic bowel.
- Venous ischaemia tends to present with more bowel wall thickening than arterial ischaemia.
- The hepatic flexure is the most commonly affected segment in ischaemic colitis.



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References

Chapter: Large Bowel

Test Your Knowledge



- 9 Which of the following statements is INCORRECT?
- Ischaemic colitis most commonly involves the watershed territories.
- CT is the first-line imaging modality for the assessment of ischaemic bowel.
- Venous ischaemia tends to present with more bowel wall thickening than arterial ischaemia.
- ✓ <u>The hepatic flexure is the most commonly affected segment in</u> <u>ischaemic colitis.</u>



Chapter Outline

Radiological Anatomy

Radiological Investigations

Acute Conditions

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References



- Ultrasound
- Colonoscopy



References



• Ultrasound





References

Chapter: Large Bowel

Chapter Outline

Radiological Anatomy

Acute Conditions

Radiological Investigations

All material used (including intellectual property and illustration elements) either originates from the authors, the authors were entitled to use the material by applicable law or have obtained a transferable license from the copyright holder.

Tumours

Colitis

Functional Disorders of the Anorectum

Take-Home Messages

References