

CME Article

Gastrointestinal tuberculosis

Chong V H, Lim K S

ABSTRACT

Tuberculosis (TB) infection is still common and remains an important cause of morbidity and mortality, particularly in underdeveloped and developing nations. The gastrointestinal (GI) tract is the sixth commonest extrapulmonary site to be affected after lymphatic, genitourinary, bones and joints, miliary and meningeal involvement. Manifestations can be non-specific and mimic many conditions, including malignancies. Findings from endoscopy and radiological imaging are myriad, and depend on the stage of the disease and the time at which investigations are carried out. Hence, diagnosis can be difficult. Endoscopy is now the investigation of choice as it allows for visualisation and the sampling of tissue for histology and culture. This is complemented by radiological imaging. This pictorial essay reviews some of the endoscopic and radiological findings of non-human immunodeficiency virus associated proven GI TB infections that we have encountered in a tertiary referral centre.

Keywords: colonic tuberculosis, gastrointestinal tuberculosis, intestinal infection, oesophageal tuberculosis, tuberculosis

Singapore Med J 2009;50(6):638-646

INTRODUCTION

Tuberculosis (TB) infection is still common and remains an important cause of morbidity and mortality, particularly in underdeveloped and developing nations. Gastrointestinal (GI) TB is the sixth commonest extrapulmonary TB site to be affected, accounting for 3%–5% of all extrapulmonary TB involvement.^(1,2) Any part of the GI tract may be involved. Overall, the prevalence depends on the severity of pulmonary TB (PTB), 1% with minimally advanced, 4.5% with moderate advanced and 25% for those with severely-advanced PTB. In fatal cases of PTB, 55%–90% have GI involvement.⁽¹⁾ Generally, 20%–25% of GI TB have evidence of PTB. Table I shows the frequency of GI tract involvement reported in the literature.

GI TB manifestations can be divided into three categories: the ulcerative form (60%), hypertrophic form (10%) and mass-like lesions (ulcerohypertrophic, 30%) that mimic malignancies.⁽¹⁾ Manifestations depend on the host's immune system. The ulcerative form occurs in those with a reduced immune response, whereas the hypertrophic

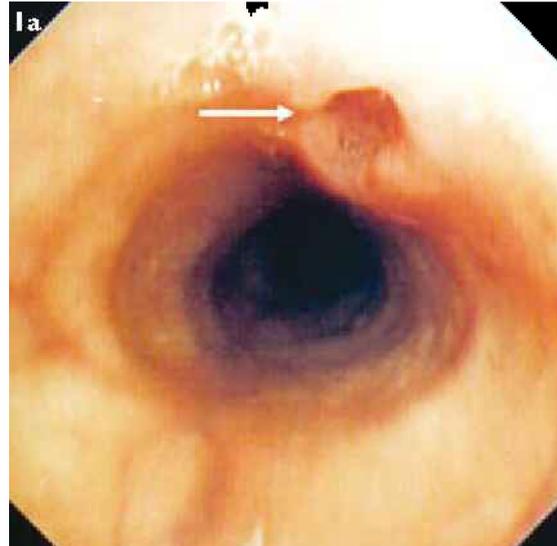


Fig. 1 (a) Endoscopic photograph shows a deep ulcer with raised irregular edges (white arrow) located in the proximal half of the oesophagus in a 73-year-old man with myelodysplasia who presented with anaemia and abdominal pain. Biopsies of the lesion showed caseating granuloma and giant cell. Ziehl-Neelsen stain was negative for acid-fast bacilli (AFB). This elderly patient also had involvements of the stomach and duodenum. (b) Barium swallow shows the same ulcer (white arrow) seen in previous figure. The long linear shadow is the nasogastric tube.

form occurs in those with an enhanced immune system.⁽³⁾ The long axis of the ulcers is perpendicular to the long

Gastroenterology
Unit,
Department of
Medicine,
Raja Isteri Pengiran
Anak Saleha
Hospital,
Bandar Seri
Begawan,
BA 1710,
Brunei Darussalam

Chong VH, MRCP,
FAMS
Consultant

Department of
Radiology

Lim KS, MRCP,
FRCR
Consultant

Correspondence to:
Dr Vui Heng Chong
Tel: (673) 877 8218
Fax: (673) 224 2690
Email: chongvuih@
yahoo.co.uk

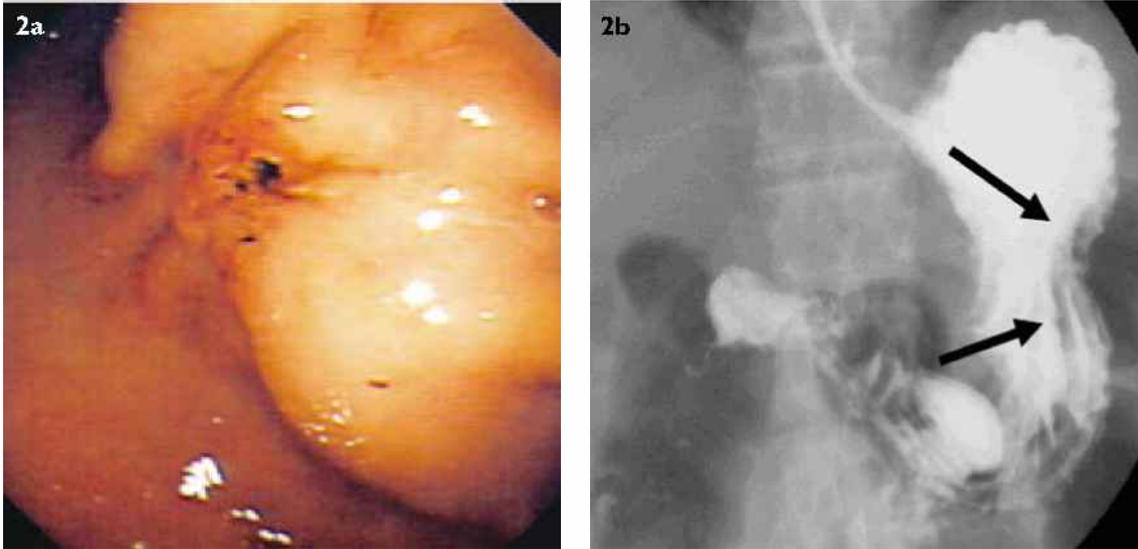


Fig. 2 (a) Endoscopic photograph shows gastric involvement in the form of an elevated mass lesion (submucosal involvements) with ulcerations at the tip in the patient from Fig. 1. The overlying mucosa appeared normal. This is most likely the result of greater curve lymph nodes involvement with extension into the stomach. (b) Barium meal of the same patient shows a lesion on the greater curve with normal overlying rugae folds (black arrows).

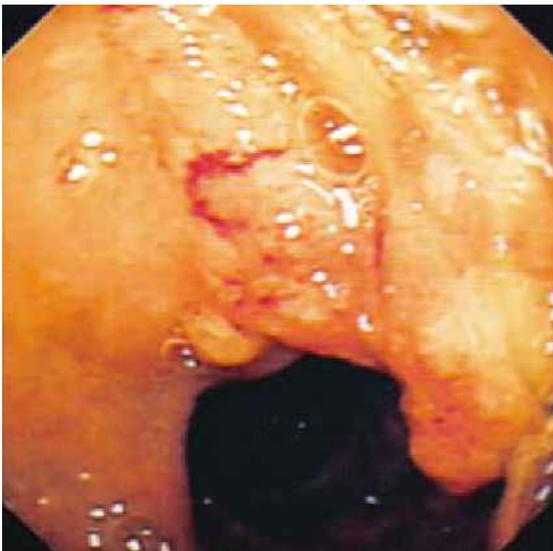


Fig. 3 Endoscopic photograph of a raised ulcerated nodular lesion at the junction of the first and second portions of duodenum in a patient with oesophageal and gastric involvements shown in Figs. 1 and 2.

axis of the bowel. Healing often results in the formation of fibrotic strictures, especially if the ulcers are deep and circumferential. The hypertrophic form consists of a thickening of the bowel wall with scarring, fibrosis and a rigid mass-like appearance that mimics that of malignancies. The ulcerohypertrophic form is a subtype with a combination of the features of the ulcerative and hypertrophic forms.

The manifestations and symptom presentations (fever, weight loss, anorexia and night sweats) can be very non-specific and mimic many conditions, including malignancies. Endoscopy is the investigation of choice

as it allows for direct visualisation and tissue sampling. However, it is limited by the accessibility of the small bowel. Radiological imaging, in particular computed tomography (CT) and contrast imaging, are complementary. Knowledge and awareness of the spectrum of manifestations and investigative findings are important. This pictorial essay reviews the endoscopic and radiological findings of proven GI TB infections encountered in a tertiary referral centre.

OESOPHAGUS

Oesophageal TB is extremely rare, accounting for only 0.15% of all TB deaths. Apart from the non-specific symptoms, common presentations include dysphagia, coughing with swallowing and haematemesis.^(4,5) The middle third of the oesophagus is usually involved. Direct extension from adjacent mediastinal structures is believed to be the main pathogenesis rather than through swallowed contaminated sputum or haematogenous/lymphatic spread. The most common manifestation is a solitary ulcer with an excavating base and rolled-up nodular edges (Figs. 1a & b). Other manifestations include external compression, fistulous connections, pseudodiverticulosis and intramural dissection. Radiologically, these features are best seen on barium swallow examinations. Mucosal nodularity on barium examination can mimic oesophageal malignancies. Mediastinal involvement and sinus tract formation are best evaluated with CT. The most serious manifestation is the aorto-oesophageal fistula, which is almost universally fatal if not treated. The differential diagnosis includes carcinoma, Crohn's disease, sarcoidosis and other infections (cytomegalovirus, human immunodeficiency virus, fungal and rarely, syphilis).

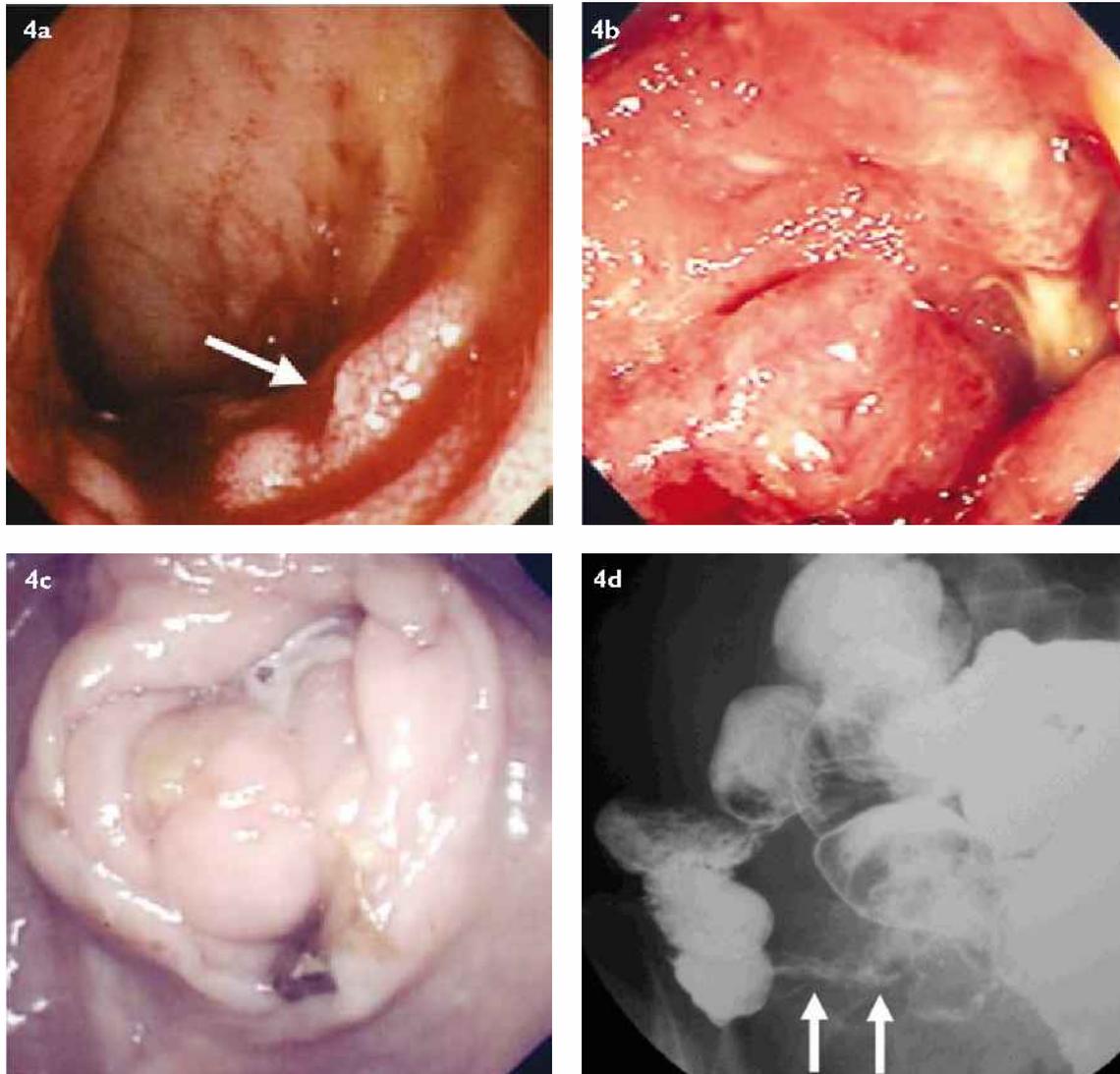


Fig. 4 (a) A middle-aged woman presented with chronic lower abdominal pain and weight loss. Ileoscopy photograph shows ileal nodules (white arrow) orientated perpendicular to the long axis of the bowel (bleeding from biopsy) seen just proximal to the ileocaecal valve. Histology showed caseating granuloma, giant cells and AFB (Ziehl-Neelsen stain). She also had calcifications of the liver. (b) Colonoscopic photograph shows an ulcerohypertrophic lesion in the ileum with friable mucosa secondary to tuberculosis. The ileal lumen was obstructed. (c) Colonoscopic photograph shows a distorted caecum and ileocaecal valve due to a mass lesion in the ileum making ileocaecal valve intubation impossible in a young woman with a few months' history of lower abdominal pain and abdominal mass. The overlying mucosa was normal. Blind biopsy of the ileum was positive for AFB. (d) Barium follow-through shows the "string sign" (white arrows) of the affected terminal ileum with dilatation of the proximal ileum (contrast study of the patient in Fig. 4c admitted for chronic abdominal pain and bowel obstruction).

STOMACH AND DUODENUM

The stomach and duodenum are rarely affected due to a combination of an acidic environment, a sparsity of lymphoid tissue and the rapid passage of swallowed mycobacterium.⁽⁶⁾ Clinical presentations include non-specific symptoms, abdominal pain or dyspepsia, GI bleeding and obstructive symptoms such as nausea and vomiting. Rare complications include obstructive jaundice. TB involvement is often unsuspected until the histology becomes available. Gastric TB is reported to be more common in males (2–3 times) and in those aged 20–40 years. Most patients have evidence of other organ involvement. Depending on the stage of the disease, manifestations range from localised to generalised

gastric mucosa involvement. The antral-pyloric complex is commonly affected, resulting in gastric outlet obstruction.⁽⁷⁾ Other manifestations include pan-gastritis, non-healing ulcers (typically on the lesser curve), malignant-looking ulcers and sub-mucosal tumours (Figs. 2a & b) due to mesenteric lymphadenitis. Diffuse gastric involvement, also known as granulomatous gastritis, can mimic linitis plastica on a barium meal. The differential diagnosis includes peptic ulcer disease, malignancies, Crohn's disease, sarcoidosis, fungal infection or idiopathic granulomatous gastritis.

The duodenum is the fourth most commonly-affected site, but over 90% of duodenal TB cases have other parts of the intestine involved. Manifestations include diffuse

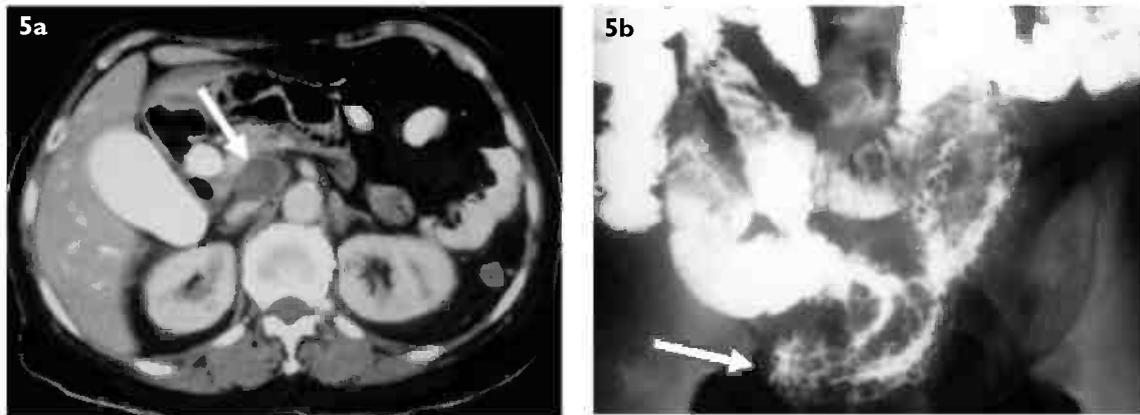


Fig. 5 (a) Axial CT image shows a large lymph node, centrally hypoechoic, corresponding to caseation (white arrow), highly suggestive of TB infection in a patient with confirmed biliary TB. (b) Small bowel contrast study shows cobble-stoning (white arrow) and skip lesions characteristic of Crohn's disease in a young man who initially presented with diarrhoea and bleeding per rectum. He later developed features of malabsorption, scrotal abscess and perianal fistula.

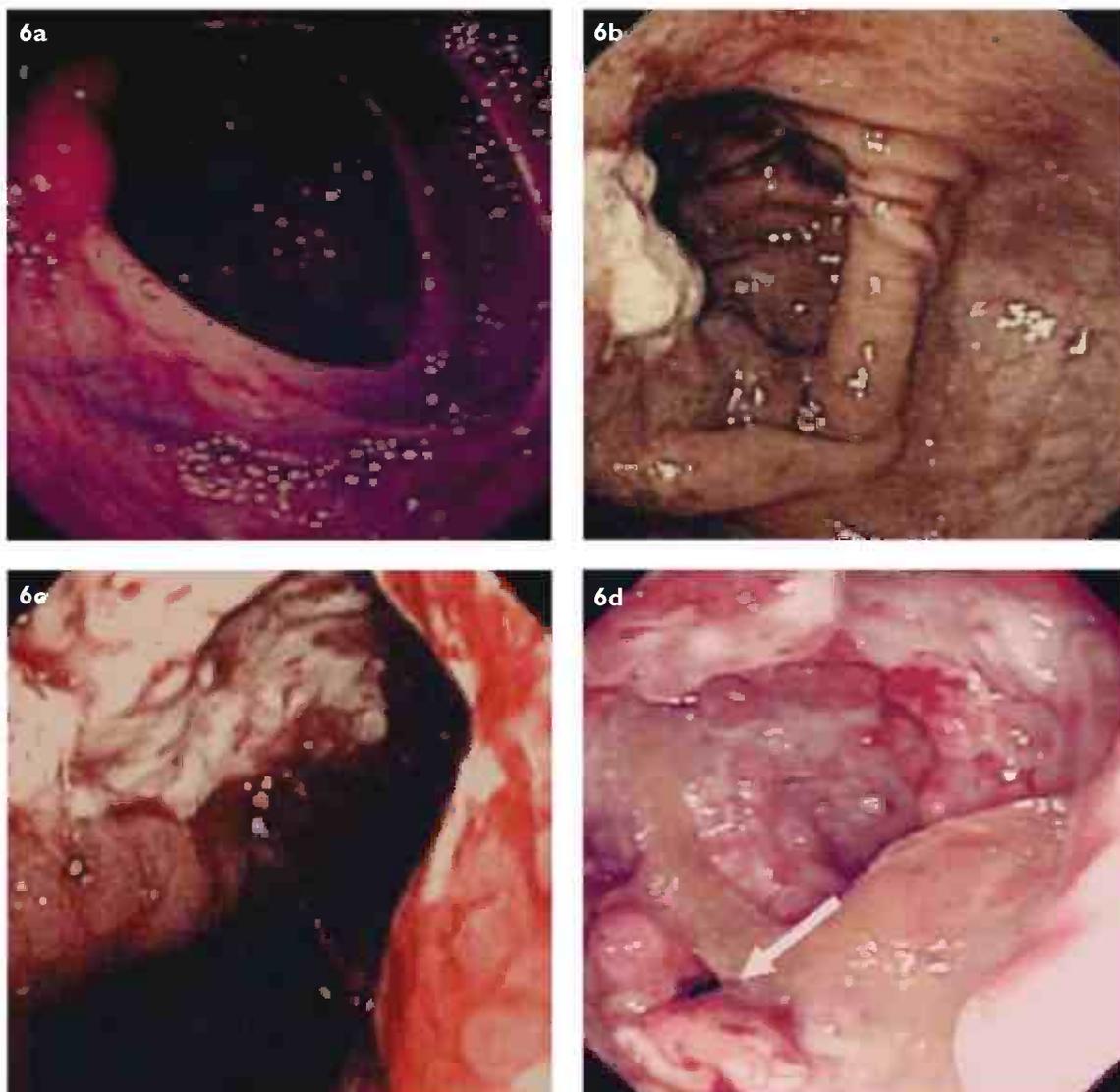


Fig. 6 (a) Colonoscopic photograph of a mildly inflamed ileocaecal valve with biopsy shows granuloma which is positive for AFB in a 70-year-old man who presented with weight loss, fever and neurological disorder later diagnosed as chronic inflammatory demyelinating polyneuropathy. He also had evidence of PTB. Treatment with anti-TB therapy led to resolution of the neurological symptoms. (b) Colonoscopic photograph shows another early ileocaecal valve involvement with ulceration and sloughing in a middle-aged woman with end-stage renal failure and who presented with abdominal pain. (c) Colonoscopic photograph shows an ulceration with necrotic sloughing progress as the condition progressed. (d) Colonoscopic photograph shows an ulcerohypertrophic caecum with multiple friable nodular lesions and grossly-thickened nodular ileocaecal valve with extension into the ascending colon (white arrow) in a middle-aged woman who presented with chronic abdominal pain and mass in the iliac fossa. The ileocaecal valve was thickened and incompetent.

Table I. Sites and frequency of tuberculosis involvement of the gastrointestinal tract.

Site	Frequency among GI TB* (%)	Overall TB* (%)
Oesophagus	1–3 (4.7)	0.15 (0.04)
Stomach	NA (4.7)	0.1–2.3 (0.04)
Small bowel		
Duodenum	2–3 (4.7)	0.2–0.6 (0.04)
Jejunum	NA (0)	NA (0)
Ileum	38 (9.5)	NA (0.09)
Colon		
Ileocecal	85–90 (38)	NA (0.36)
Appendix	NA (19)	≤ 4 (0.18)
Ascending colon†	35 (23.8)	NA (0.23)
Transverse colon‡	16 (0)	NA (0)
Descending colon	8 (0)	NA (0)
Recto-sigmoid colon	13 (0)	NA (0)
Anal	NA (4.7)	NA (0.04)

* prevalence rates listed are based on literatures searches of relevant articles. The data in parenthesis refers to the frequency in our local setting (based on data from 1997 to 2004, from National TB Coordinating Centre, NTCC).

† includes hepatic flexure

‡ includes splenic flexure

GI TB: Gastrointestinal tuberculosis; NA: Not available

Note: Data on the prevalence of GI involvements including our local data is probably an underestimate of the actual involvements; early stages might not be diagnosed as further investigations are often not carried out once the diagnosis has been made.

mucosal fold thickening, ulcers or an ulcerated mass (Fig. 3), polyps, stricture formation and fistulae, such as choledochoduodenal fistula. The ulcers are usually transverse and circular. Simultaneous involvement of the pylorus is common but is not specific to TB. The largest series reported, which consisted of 28 cases, showed that the majority (82.2%) had obstructive symptoms secondary to luminal narrowing, of which 72% was due to external compression. The others had dyspepsia secondary to ulcerations.⁽⁸⁾

JEJUNUM

The jejunum is the third most commonly-affected site. Despite this, there are very few reports, probably as a result of difficulties in visualising this area, except in postmortem studies. Apart from the non-specific symptoms, the most common symptom is chronic abdominal pain. Malabsorption is a well-recognised complication, probably as a result of bacterial overgrowth. Up to 70% of patients in endemic areas may have jejunal strictures. Ulcers are also common. With the advent of double balloon enteroscopy and capsule endoscopy, more cases will be diagnosed. The spectrum of lesions encountered is similar to those seen in the rest of the intestine.

ILEUM

The ileum is the most commonly-affected site, either in isolation or with the involvement of the adjacent bowel

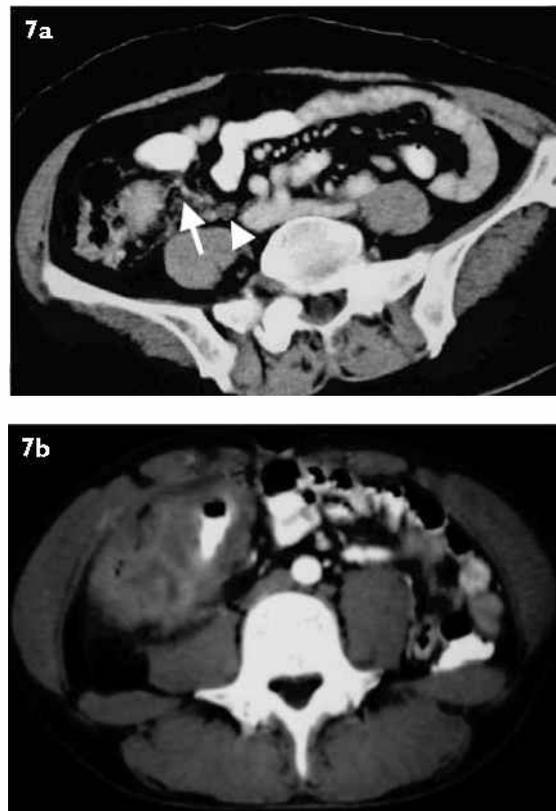


Fig. 7 (a) Axial CT image shows TB ileocecal involvement at an early stage of the disease, thickening of the ileum (white arrow) and caecum. Regional enlarged lymph nodes may be seen (white arrowhead). (b) With disease progression, axial CT image shows the ascending colon to be thickened, resulting in mass formation and luminal narrowing in an elderly man who presented with weight loss, abdominal pain and distension. This may lead to bowel obstruction.

segments, especially the caecum. The main reasons for the predilection are due to a high density of lymphoid tissue, relatively longer faecal stasis, a neutral pH environment and absorptive transport mechanisms that allow swallowed mycobacterium to be absorbed.⁽⁹⁾ Common presentations include abdominal pain and an abdominal mass in the right iliac fossa. Depending on the stage of the disease, findings may range from a normal appearance to small polyps or nodules to extensive ulcerations, hypertrophic, ulcerohypertrophic and fibrotic lesions resulting in strictures, causing bowel obstructions and fistulae formations (Figs. 4a–d). Both endoscopy and radiological imaging can be used depending on the site affected. Rapid emptying of contrast, known as the “Stierlin’s sign”, is commonly seen in terminal ileum involvement due to persistent irritability of the mucosa. Bowel wall thickening, mass lesions and regional adenopathy are best seen on CT. Differentiating ileal TB from Crohn’s disease can be very difficult. Furthermore, these two conditions may coexist. The presence of centrally necrotic regional lymph nodes favours TB (Fig. 5a), whereas a cobble-stone appearance (Fig. 5b) and skip lesions favour Crohn’s disease.

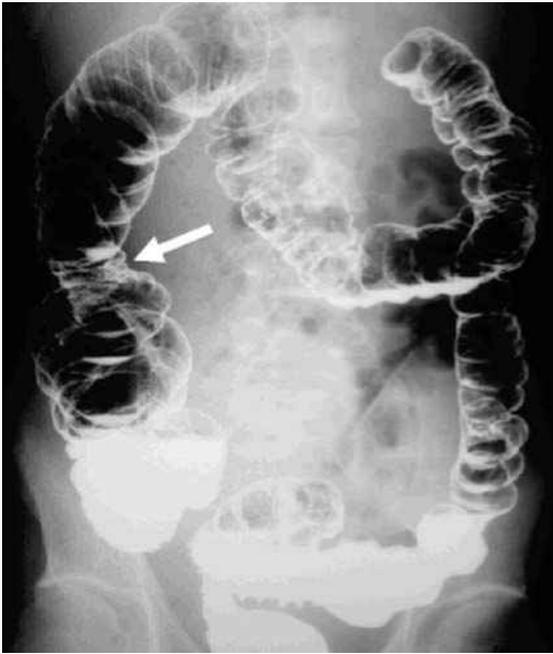


Fig. 8 Double contrast barium enema in a 42-year-old man who presented with abdominal pain shows a short stricture of the ascending colon. This is secondary to the fibrotic healing of previous circumferential ulcers (white arrow). He also had concomitant PTB.

LARGE BOWEL

The colon is the second most commonly-affected site, especially the caecum and the ascending colon, decreasing in frequency with increasing distance from the caecum.⁽¹⁰⁾ Common presentations include abdominal pain, a chronic abdominal mass and altered bowel habits. Serious complications include intestinal obstruction (15%–60%), fistulae (25%), perforation (15%, with a mortality of 30%–40%) and less frequently, massive haemorrhage.

Appendix

Appendicular TB is rare, accounting for up to 2.9% of all appendectomies done in the endemic area. Presentations resemble acute appendicitis. Most are diagnosed when the histology unexpectedly show granulomas with or without caseation and AFB.⁽¹¹⁾

Caecum and ascending colon

The caecum is commonly involved, along with the terminal ileum. In the early stages, the endoscopical appearances may be normal, resemble mild non-specific colitis or consist of small polyps (Figs. 6a & b). With progression, the caecal and ileal walls become thickened, with enlargement of the draining lymph nodes. The caecum is typically involved as the ulcerohypertrophic type, resulting in mass-like lesions mimicking malignancies or Crohn's disease (Figs. 6c & d). CT imaging may show a thickened ileum with caecal and ascending colon involvement as the disease progresses (Figs. 7a & b). A chronically-scarred caecum often assumes

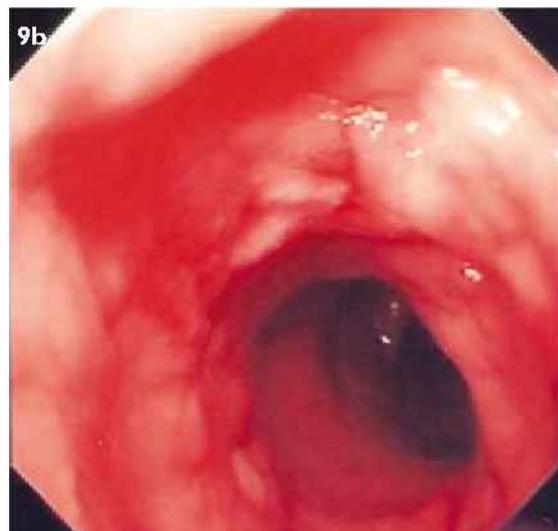


Fig. 9 (a) Compared to Fig. 6d, colonoscopic photograph shows nodular lesions secondary to Crohn's disease can be difficult to differentiate from TB or colon cancer based on endoscopy alone. (b) Colonoscopic photograph shows Crohn's disease stricture can be difficult to differentiate from that of TB stricture.

a deformed cone configuration, which is well appreciated on barium studies. The ileocaecal valve usually becomes enlarged and patulous. A swollen gaping ileocaecal valve, a cone-shaped caecum and a narrowed adjacent terminal ileum give rise to the “inverted umbrella” defect seen on barium studies, better known as the “Fleischner sign”. However, these signs may not be often present.

The ascending colon may be involved in isolation but usually occurs in association with caecal involvement. The findings are similar to those of caecal involvement. Strictures often mimic a malignancy (Fig. 8), although a short segment involvement usually gives rise to an hour-glass shaped stricture rather than an apple-core one (as with malignancy) on barium studies. Involvement can also mimic ulcerative colitis. Severe nodular or constrictive involvement can lead to bowel obstruction. Crohn's disease

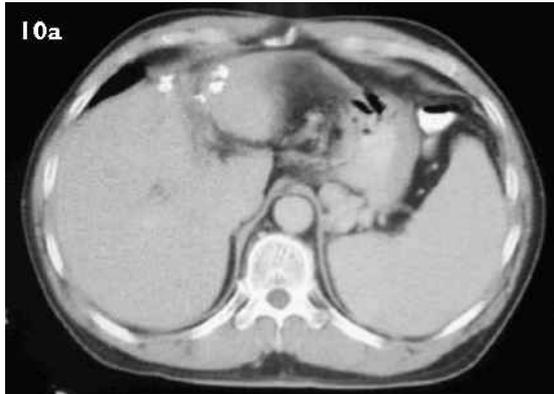


Fig. 10 (a) Axial CT image shows hepatic calcification in segments three and four, indicating hepatic involvement in a patient with GI TB. Calcification can be minimal to florid calcification affecting a large part of the liver. (b) Axial CT image shows extensive fatty infiltration in the mesentery and thickened ascending colon in an elderly man who was diagnosed with TB involving the ileocaecum and ascending colon. This patient also had hepatic calcifications. (c) Axial CT image shows mesentery and peritoneal involvements with irregular outline in addition to the presence of ascites.

and colon cancer can be difficult to differentiate from TB involvement endoscopically (Figs. 9a & b), and often requires histology or culture confirmation.

Transverse, descending, sigmoid colon and rectum

The involvement of these parts of the colon is more common than the stomach, duodenum and oesophagus. However, isolated involvement, also known as segmental colonic TB, is rare. The ileocaecum or the ascending colon tends to be involved simultaneously. Findings are similar to those encountered in the proximal colon. Endoscopic and radiological findings include those of non-specific colitis, aphthoid ulcers, colitis resembling inflammatory bowel disease, diminutive to large nodular polyps or mass lesions resembling colorectal malignancies. In addition to the non-specific symptoms, manifestations of segmental colonic TB include chronic abdominal pain, altered bowel habit and bleeding per rectum. Bleeding tends to be minor, although massive haematochezia have been reported.

Extra-enteric involvement

As the simultaneous involvement of other organs is common, it is important to search for the presence of TB infection in other organs, especially the chest and liver. Hepatic calcifications may be seen, ranging from a few specks to heavy calcifications (Fig. 10a). Tuberculous lymph nodes are typically centrally hypodense on CT (Fig. 5a), corresponding to caseation. Peritoneal and omental

involvement give rise to large irregular masses (sometimes with central necrosis) and high density ascites (Fig. 10b). The mesentery and the peritoneum may be involved (Fig. 10c). Solid organ involvement, commonly the liver and the kidney, often manifest as calcified hypodense masses. These are best evaluated with CT. Suggestive symptoms, laboratory investigation findings of elevated erythrocyte sedimentation rates, anaemia and hypoalbuminaemia, should heighten suspicion for GI TB.

CONCLUSION

This pictorial essay underscores the varied manifestations of patients with underlying GI TB and the importance of knowledge of the different manifestations and investigative findings (endoscopic and imaging) in the management of these patients. In our patients, the findings from endoscopy and radiological imaging represent those cases that have advanced disease. As treatment for TB infections is standardised and effective, making the correct diagnosis early is very important. Clinical awareness and suspicion are very important. These should be supplemented by other investigations such as histology, culture, use of a skin test for TB exposure, and the use of more advanced tests such as the polymerase chain reaction and fluid adenosine deaminase. Knowledge of the local or regional prevalence and the spectrum of TB manifestations are also very crucial.

REFERENCES

1. Hamer DH, Gorbach SL. Tuberculosis of the intestinal tract. In: Felman M, Scharschmidt BF, Sleisenger MH, eds. Sleisenger and Fordtrans's Gastrointestinal and Liver Disease. Pathophysiology/Diagnosis/Management. 6th ed. Vol 2. Philadelphia: WB Saunders, 1998: 1622-4.

2. Marshall JB. Tuberculosis of the gastrointestinal tract and peritoneum. *Am J Gastroenterol* 1993; 88:989-99.
3. Acharya SK, Tandon BN. Abdominal Tuberculosis. In: Watters D, Kiire C, eds. *Gastroenterology in the Tropics and Subtropics: A Practical Approach*. 10th ed. London and Basingstoke: Macmillan Education, 2005: 85-102.
4. Abid S, Jafri W, Hamid S, Khan H, Hussainy A. Endoscopic features of esophageal tuberculosis. *Gastrointest Endosc* 2003; 57:759-62.
5. Mokoena T, Shama DM, Nagakane H, Bryer JV. Oesophageal tuberculosis: a review of eleven cases. *Postgrad Med J* 1992; 68:110-5.
6. Yeomans ND, Lambert JR. Infections of the stomach and duodenum. In: Haubrich WS, Schaffner F, Berk JE. *Bockus Gastroenterology*. 5th ed. Vol 1. Philadelphia: WB Saunders, 1994: 805-15.
7. Amarpurkar DN, Patel ND, Amarpurkar AD. Primary gastric tuberculosis--report of 5 cases. *BMC Gastroenterol* 2003; 3:6.
8. Chavhan GE, Ramakantan R. Duodenal tuberculosis: radiological features on barium studies and their clinical correlation in 28 cases. *J Postgrad Med* 2003; 49:214-7.
9. Sharma MP, Bhatia V. Abdominal tuberculosis. *Indian J Med Res* 2004; 120:305-15.
10. Mukewar S, Mukerwar S, Dua KS. Tuberculosis of the colon: endoscopic features with prospective follow-up after anti-tuberculosis treatment. *Gastrointest Endosc* 2007; 65:AB253.
11. Gupta SC, Gupta AK, Keswani NK, et al. Pathology of tropical appendicitis. *J Clin Pathol* 1989; 42:1169-72.

SINGAPORE MEDICAL COUNCIL CATEGORY 3B CME PROGRAMME
Multiple Choice Questions (Code SMJ 200906B)

	True	False
Question 1. Concerning gastrointestinal tuberculosis:		
(a) The gastrointestinal tract is the most common extrapulmonary site to be affected, accounting for 3%–5% of all extrapulmonary tuberculosis.	<input type="checkbox"/>	<input type="checkbox"/>
(b) Manifestations can be non-specific and may mimic malignancies.	<input type="checkbox"/>	<input type="checkbox"/>
(c) Findings are dependent on the stage and severity of the infection at the time of investigation.	<input type="checkbox"/>	<input type="checkbox"/>
(d) Prevalence is correlated with the severity of pulmonary involvement.	<input type="checkbox"/>	<input type="checkbox"/>
Question 2. Regarding gastrointestinal tuberculosis involvement of the oesophagus and stomach:		
(a) Oesophageal involvement is extremely rare.	<input type="checkbox"/>	<input type="checkbox"/>
(b) The most common manifestation is aorto-oesophageal fistula.	<input type="checkbox"/>	<input type="checkbox"/>
(c) Gastric manifestations mimic many conditions and a diagnosis is often made after histological examination.	<input type="checkbox"/>	<input type="checkbox"/>
(d) Rapid transit, sparse lymphoid tissue and an acidic environment are important factors.	<input type="checkbox"/>	<input type="checkbox"/>
Question 3. Regarding the involvement of the small bowel by tuberculosis:		
(a) The duodenum is the fourth most commonly-affected site and simultaneous involvement of the antrum is common.	<input type="checkbox"/>	<input type="checkbox"/>
(b) The jejunum is rarely affected.	<input type="checkbox"/>	<input type="checkbox"/>
(c) Ulcers and strictures are common manifestations in the jejunum.	<input type="checkbox"/>	<input type="checkbox"/>
(d) Malabsorption is directly due to tuberculous involvement.	<input type="checkbox"/>	<input type="checkbox"/>
Question 4. Concerning tuberculous ileal involvement:		
(a) The ileum is the most commonly-affected site either in isolation or in association with caecal involvement.	<input type="checkbox"/>	<input type="checkbox"/>
(b) Abdominal pain and a right iliac fossa mass are unusual.	<input type="checkbox"/>	<input type="checkbox"/>
(c) The “Stierlin’s sign” indicates rapid emptying secondary to persistent irritability of the ileum.	<input type="checkbox"/>	<input type="checkbox"/>
(d) Crohn’s disease can be easily differentiated from tuberculous involvement of the ileum.	<input type="checkbox"/>	<input type="checkbox"/>
Question 5. Regarding large bowel tuberculosis:		
(a) Segmental colonic involvement is very common.	<input type="checkbox"/>	<input type="checkbox"/>
(b) Complications include bowel obstructions, fistula formation and perforation.	<input type="checkbox"/>	<input type="checkbox"/>
(c) Appendix involvements are often incidental findings.	<input type="checkbox"/>	<input type="checkbox"/>
(d) Differential diagnosis of colonic tuberculosis includes colorectal cancer.	<input type="checkbox"/>	<input type="checkbox"/>

Doctor’s particulars:

Name in full: _____

MCR number: _____ Specialty: _____

Email address: _____

SUBMISSION INSTRUCTIONS:

(1) Log on at the SMJ website: <http://www.sma.org.sg/cme/smj> and select the appropriate set of questions. (2) Select your answers and provide your name, email address and MCR number. Click on “Submit answers” to submit.

RESULTS:

(1) Answers will be published in the SMJ August 2009 issue. (2) The MCR numbers of successful candidates will be posted online at www.sma.org.sg/cme/smj by 15 August 2009. (3) All online submissions will receive an automatic email acknowledgment. (4) Passing mark is 60%. No mark will be deducted for incorrect answers. (5) The SMJ editorial office will submit the list of successful candidates to the Singapore Medical Council.

Deadline for submission: (June 2009 SMJ 3B CME programme): 12 noon, 7 August 2009.