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Computed tomographic features of abdominal tuberculosis: unmask the impersonator!

Sneha Satish Deshpande,[1] Anagha Rajeev Joshi,[1] Saurabh Satish Deshpande,[1] and Soyaf A. Phajlani[1,2]

[1]Department of Radiology, Lokmanya Tilak Municipal Medical College and General Hospital, Sion, Mumbai 400022, India
[2]Department of Radiology, Government Medical College, Nagpur 440009, India

Abstract

Purpose: Abdominal tuberculosis (ATB) mimics various infectious, inflammatory, and neoplastic conditions and hence requires a high index of suspicion for accurate diagnosis, especially in low prevalence areas. It is difficult to consistently establish a histopathological diagnosis of ATB which underlines the importance of supportive evidences for institution of prompt empirical therapy to prevent associated morbidity and mortality.
Methods: We retrospectively evaluated clinical and imaging features of 105 ATB cases and classified their CT findings based on peritoneal, lymph node, bowel, and solid organ involvement. Concomitant pulmonary and extra-pulmonary involvement was assessed.
Results: Abdominal pain (78.1%) followed by fever (42.9%) were the commonest presenting symptoms. Peritoneal TB (77.14%) most commonly presented with a mix of ascites (49.38%), peritoneal (28.40%), and omental involvement (27.16%). Lymphadenopathy (57.1%) most commonly presented as necrotic nodes (81.67%) at mesenteric, peripancreatic, periportal, and upper paraaortic regions. Commonest site of bowel involvement (cumulative of 62.85%) was ileocecal region, with the commonest pattern of involvement being circumferential bowel wall thickening without bowel stratification with mild luminal narrowing. Hepatic (13.33%) and splenic (16.2%) involvement predominantly presented as multiple microabscesses. Adrenal and pancreatic involvement was noted in 4.7% and 1.9% of patients, respectively. 38.1% patients showed concomitant pulmonary and extra-pulmonary TB.
Conclusion: ATB has varied radiological features; however, peritoneal involvement in the form of mild ascites, smooth peritoneal thickening, smudgy omentum, multifocal bowel involvement, necrotic nodes, and multiple visceral microabscesses point towards a diagnosis of ATB in appropriate clinical setting.

Key words: Abdominal tuberculosis—Peritoneal thickening—Necrotic nodes—Ileocecal tuberculosis—Hepatic and splenic microabscesses

Tuberculosis (TB) has become a global emergency, which is further complicated by AIDS/HIV infection and the increasing use of immunosuppressant drugs. India accounts for the largest TB burden in the world with the World Health Organization TB statistics for India for 2016 giving an estimated incidence of 2.79 million cases [1]. TB can involve multiple organ systems, with abdominal tuberculosis being one of the commonest sites of extra-pulmonary involvement (10%–15%) [2]. It can clinically mimic varied diseases like inflammatory bowel disease, malignancy, and other infectious diseases. Untreated or delayed institution of treatment can result in increased morbidity and mortality. It therefore mandates early diagnosis and treatment initiation. CT is fast, widely available, and offers wide coverage with good spatial and temporal resolution. It is therefore the investigation of choice in many centers to evaluate suspected or diagnosed abdominal tuberculosis.

The causative organism of abdominal tuberculosis is mycobacterium tuberculosis or non-tuberculous mycobacteria, the latter being more common in immunocompromised hosts. The postulated mechanisms by which the bacilli reach gastrointestinal tract are (i) hematogenous spread from the primary lung focus, with later reactivation; (ii) ingestion of bacilli in sputum from active pulmonary focus; (iii) direct spread from adjacent organs; and (iv) and through lymphatic channels from infected nodes [3, 4]. Histopathological diagnosis of tuberculosis with demonstration of acid fast bacilli and caseating granulomas is gold standard for diagnosis of

Correspondence to: Sneha Satish Deshpande; *email:* d_snehamumbai@yahoo.com

abdominal tuberculosis. However, this is not always feasible in many clinical scenarios. Also, this may lead to unnecessary delay caused by time-consuming tests which may lead to clinical worsening of the patient and poor outcomes.

Hence, radiological investigations play a pivotal role in the diagnosis of abdominal tuberculosis in conjunction with other cytological and immunological investigations, which underlines the importance of studying its common as well as uncommon presentations. For radiological diagnosis to be accurate, each imaging finding needs to be documented with precision and the entire ensemble needs to be analyzed in the light of clinical presentation. We retrospectively evaluated 105 patients with proven abdominal tuberculosis (on presentation or on follow-up) for their clinical presentation and CT features based on involvement of peritoneum, lymph nodes, bowel, and solid organs (including liver, spleen, pancreas, and adrenal) with concomitant involvement of pulmonary or other extra-pulmonary sites.

Methods and materials

Subjects

The study was started after approval from the Institutional Review Board. We conducted a retrospective descriptive study of patients referred to our department over a period of one year (from January 2016 to December 2016) with proven ATB. The diagnosis of abdominal tuberculosis was established on the basis of at least one of the following criteria: (a) Histological evidence of caseating granulomas. (b) Histological demonstration of acid fast bacilli in the lesion or ascitic fluid. (c) Growth of mycobacterium tuberculosis on culture of tissue or ascitic fluid. (d) Satisfactory therapeutic response to anti-tuberculous treatment on follow-up scans in patients with clinical, radiological, or operative evidence of ATB. Patients below 18 years of age were excluded from the study.

Clinical presentation

The patients were questioned regarding the following symptoms: (a) pain in abdomen, (b) fever, (c) loss of appetite, (d) loss of weight, (e) constipation, (f) vomiting, (g) abdominal distension, (h) obstipation, and (i) diarrhea.

Scanning parameters

CT scans of abdomen were performed as a part of their routine diagnostic work on 64 slice MDCT scanner (Philips Brilliance, Philips Medical Systems) after taking informed consent with no change in the hospital protocol.

Images were acquired in thin collimation depending on the phase. Image reconstruction was carried out on Terarecon's Aquarius workstation. Axial images were reconstructed using a slice thickness of 2 mm and 1 mm reconstruction increment, and thinner if need be and viewed at standard soft tissue window settings. The scans were independently reviewed by 2 radiologists and any disagreement was resolved by combined review of the scans and a consensus reached.

Multi-detector computed tomography evaluation

CT findings were analyzed based on peritoneal, lymph nodes, bowel, and solid organ involvement. Peritoneal involvement was assessed as peritoneal thickening or nodules or masses, enhancement, and calcification. Omental infiltration was classified as smudged pattern, thickening or caking, and omental nodularity. Presence of ascites was noted with the amount of fluid graded as mild (not measurable), moderate (depth of less than 3 cm), and severe (depth of more than 3 cm). Nodal involvement was assessed based on the presence and site of lymphadenopathy and pattern of enhancement. Bowel involvement was assessed in the form of site, pattern, and extent of involvement. Bowel involvement was recorded as single or multiple segment involvement and based on the length of involvement as focal (< 5 cm), segmental (> 5 cm), or diffuse bowel involvement. Complications of abdominal tuberculosis were recorded in the form of obstruction, cocoon formation, perforation, and fistula formation. Liver and spleen involvement was assessed as single, multiple granulomas, or abscesses (micro or macroabscesses) and calcific granulomas. Adrenal involvement was noted as being unilateral, bilateral, and calcified lesions. Pancreatic involvement was assessed.

Statistical analysis

Data were analyzed using statistical package for social sciences (SPSS) version 17.0 for Windows (SPSS, Chicago IL, USA). Mean and standard deviation were calculated for continuous variables. Proportions and frequency tables were used to analyze categorical variables.

Results

We retrospectively analyzed CT scans of 105 patients of abdominal tuberculosis with mean age of 32 ± 13 years (18–78 years). Of these patients, 45 were males (42.9%) and 60 (57.1%) were females with mean age of 35.1 ± 13.4 years (18–78 years) and 29.8 ± 12.5 years (18–75 years), respectively.

The common presenting symptoms of these patients were analyzed which revealed pain in abdomen in 82 patients (78.1%), fever in 45 patients (42.9%), loss of

appetite and weight in 31 patients (29.5% each), constipation in 30 patients (28.5%), vomiting in 43 patients (41%), abdominal distension in 25 patients (23.8%), obstipation in 1 (1%), and diarrhea in 9 patients (8.6%).

CT scans were analyzed based on peritoneal, lymph nodes, bowel, and solid organ involvement (Table 1). Peritoneal involvement was noted in a cumulative of 81 patients (77.14%) (Fig. 1). Peritoneal thickening was noted in 23/81 patients (28.40%) with smooth peritoneal thickening noted in 20/23 patients (86.95%), sub-centimeter enhancing peritoneal nodules noted in 3/23 patients (13.04%), while none of these patients showed peritoneal masses. Omental infiltration [22/81 patients (27.16%)] in the form of smudged pattern was noted in 11/22 patients (50%), omental nodules in 9/22 patients (40.90%), and omental caking in 2/22 patients (9.09%). Ascites was noted in 40/81 patients (49.38%), being mild in 22/40 (55%), moderate in 7/40 (17.5%), and severe in 11/40 (27.5%) patients.

Lymphadenopathy was noted in 60 patients (57.1%), with all these patients showing multiple abdominal nodes (Fig. 2). 49/ 60 patients (81.6%) showed enlarged nodes with peripheral enhancement and central non-enhancing necrotic area, while 16/60 patients (26.6%) showed conglomerated nodes forming nodal masses with mean short axis diameter being 2 ± 0.7 cm (1.2–4 cm). 11/60 patients (18.4%) showed homogenously enhancing nodes. Calcified nodes were seen in 16/60 patients (26.6%);

Table 1. Radiological features of abdominal tuberculosis

Organ involvement	Radiological features	Patterns	Number of patients (%)
Peritoneal tuberculosis [81/105 patients (77.14%)]	Peritoneal thickening 23/81 patients (28.40%)	Smooth peritoneal thickening	20/23 (86.96%)
		Enhancing peritoneal nodules	3/23 (13.04%)
		Peritoneal masses	None
	Omental infiltration 22/81 patients (27.16%)	Smudged pattern	11/22 (50%)
		Omental nodules	9 /22 (40.90%)
		Omental caking	2/22 (9.09%)
	Ascites 40/81 patients (49.38%)	Mild	22/40 (55%)
		Moderate	7 /40 (17.5%)
		Severe	11 /40 (27.5%)
Lymphadenopathy [60/105 patients (57.1%)]	Enlarged nodes with peripheral enhancement and central non-enhancing necrotic area		49/60 (81.67%)
	Conglomerated nodes forming nodal masses		16 /60 (26.67%)
	Homogenously enhancing nodes		11/60 (18.33%)
	Calcified nodes		16 /60 (26.67%)
Bowel involvement [66/105 patients (62.85%)]	Esophagus	Esophago-mediastinal fistula	1/66 (1.5%)
	Stomach		None
	Small bowel involvement 64/66 patients (96.97%)	Single short segment stricture (focal)	6/64 (9.3%)
		Multiple short segment strictures	8 /64 (12.5%)
		Single long segment stricture (segmental)	1 /64 (1.5%)
		Multiple long segment strictures (segmental)	2/64 (3.1%)
		Terminal ileum, ileocecal valve with concomitant involvement of the cecum	47 /64 (73.43%).
	Large bowel involvement 19/66 patients (28.79%)	Single long segment stricture	15/19 (78.95%) 14/15 patients (93.3%) showed contiguous involvement of ascending colon with concomitant involvement of ileocecal region.
		Single short segment stricture	2/19 patients (10.52%)
		Multiple long segment strictures	2/19 patients (10.52%)
Hepatic involvement [14/105 patients (13.33%)]	Multiple microabscesses		5/14 (35.7%)
	Calcific granulomas		9/14 (64.2%)
	Macroabscesses		None
Splenic involvement [17/105 patients (16.2%)]	Single macroabscess		2/17 (11.7%)
	Multiple microabscesses		11/17 (64.7%)
	Calcified granulomas		4/17 (23.5%)
Adrenal involvement [5 patients (4.7%)]	Bilateral		3/5 (60%)
	Unilateral		2/5 (40%)
Pancreatic involvement	Single peripherally enhancing abscess		2/105 (1.9%)

Fig. 1. (**A**) Axial CECT image of abdomen showing severe ascites with peritoneal thickening (red arrow) (**B**) smudged pattern of omental involvement (red arrow). (**C**) CECT thorax of the same patient shows concomitant necrotic conglomerated right hilar nodes (red arrow) with pleural effusion (yellow arrow).

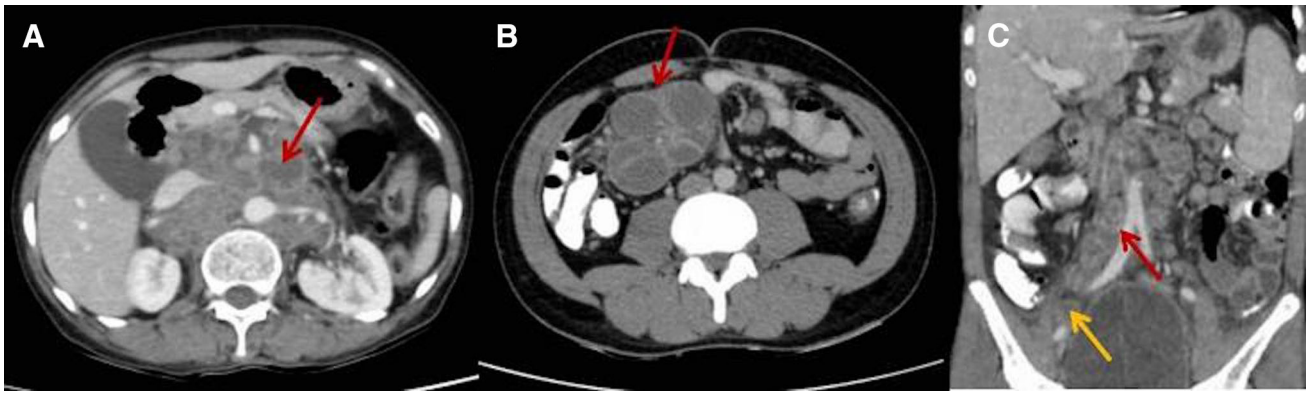

Fig. 2. (**A**) Axial CECT image of abdomen showing multiple enlarged necrotic conglomerated nodes in the upper retroperitoneum (red arrow) (**B**) Axial CECT image of abdomen showing conglomerated nodal mass in the mesentery showing multilocular appearance (red arrow). (**C**) Coronal CECT image shows retroperitoneal nodes also involving the lower paraaortic (red arrow) and iliac regions (yellow arrow) in disseminated tuberculosis.

however, all of these were seen in association with necrotic or non-necrotic enlarged nodes at other sites. 4 patients (6.67%) showed iliac nodal involvement and 1 (1.67%) showed inguinal nodal involvement; however, isolated involvement of these sites was not seen in any of the patients. All the patients showed involvement of at least one of the sites including mesenteric, periportal, peripancreatic, and upper paraaortic regions.

Bowel involvement was noted in a cumulative of 66 patients (62.85%) (Fig. 3). Esophagus was involved in one patient, with esophago-mediastinal fistula. No stomach involvement was noted. Small bowel involvement was noted in 64/66 patients (96.97%), with various distribution patterns being single short segment stricture (focal) in 6 patients (9.3%), multiple short segment strictures in 8 patients (12.5%), single long segment stricture (segmental) in 1 patient (1.5%), multiple long segment strictures (segmental) in 2 patients (3.1%), and involvement of the terminal ileum, ileocecal valve with concomitant involvement of the cecum in 47 patients (73.4%). The most common pattern of bowel wall involvement was homogenously enhancing circumferential symmetric bowel wall thickening without bowel stratification, average wall thickness being 6.7 ± 1.9 mm (5–11 mm). Small bowel obstruction was noted in 25 patients (39%) (Fig. 4), while 2 (3.1%) presented with perforation. Cocoon formation was seen in 14 patients (21.8%) and fistula formation was not seen in any of the patients (Table 2). Large bowel involvement was noted in 19 of patients (18.1%), with the commonest presentation being single long segment stricture which was seen in 15 patients (78.95%). 14/15 patients (93.3%) showed contiguous involvement of ascending colon with concomitant involvement of ileocecal region. The other patterns of involvement were single short segment stricture and multiple long segment strictures in 2 patients (10.5%) each. 2/19 patients (10.5%) presented with obstruction, with none of them showing perforation or fistula formation (Table 2). Isolated large bowel involvement with no small bowel disease was seen in 2/66 patients (3%).

Hepatic involvement was noted in 14 patients (13.33%) in the form of multiple microabscesses in 5/14 (35.7%), calcific granulomas in 9/14 (64.2%), and none of

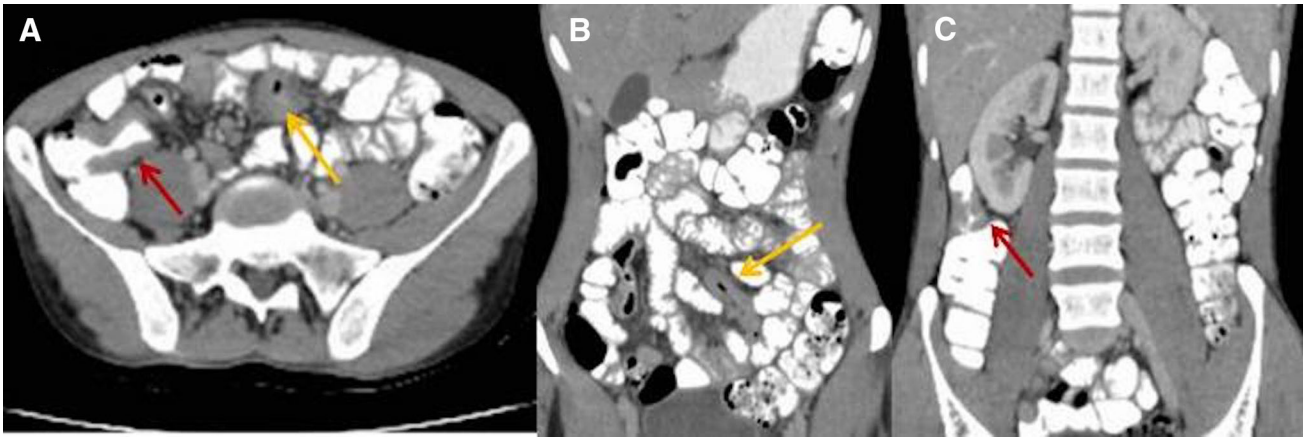

Fig. 3. (**A**) Axial CECT image showing ileocecal circumferential enhancing wall thickening without bowel stratification (red arrow). (**B**) This patient showed another focal area of bowel wall thickening in the ileum (yellow arrow) which is also seen in the corresponding coronal image. (**C**) This patient showed a short segment of ascending colon wall thickening (red arrow).

Fig. 4. Axial CECT image showing circumferential enhancing wall thickening without bowel stratification involving a distal ileal loop (red arrow) leading to luminal narrowing and resultant small bowel obstruction.

them showing macroabscesses (Fig. 5). Splenic involvement was noted in 17 patients (16.2%), being single macroabscess in 2/17 (11.7%), multiple microabscesses in 11/17 patients (64.7%), and calcified granulomas in 4/17 patients (23.5%) (Fig. 6). Adrenal involvement was noted in 5 patients (4.7%), being bilateral in 3/5 patients (60%) and unilateral in 2/5 patients (40%). 4 patients showed well-defined hypodense hypoenhancing adrenal lesions, with two of these patients showing punctate foci of calcification (Fig. 7). Pancreatic involvement was noted in 2 patients (1.9%) which presented as a single peripherally enhancing abscess (Fig. 8).

40 patients (38.1%) showed concomitant involvement of other sites, including lung [12 (11.4%)], pleural involvement [6 (5.7%)], bone [8 (7.6%)], and tuberculous meningitis [4(3.8%)]. 10 patients showed genitourinary involvement [3 patients showed renal and ureteric involvement (2.8%), 6 patients presented with bilateral tubo-ovarian masses (5.7%), and 1 had prostatic abscess (0.9%)] (Fig. 9).

Discussion

Abdominal tuberculosis is one of the commonest forms of extra-pulmonary tuberculosis [2] presenting with various perplexing radiological features and a diverse mix of organ involvement. It presents with non-specific clinical features, predominantly in young adults with no significant gender predilection; however, some studies show slight female preponderance [5–7]. The clinical presentation of abdominal tuberculosis can be acute, chronic,

Table 2. Bowel complications of abdominal tuberculosis

	Complication	Number of patients (percentage)
Small bowel involvement (64 patients)	Obstruction	25/64 (39%)
	Perforation	2 /64 (3.12%)
	Cocoon formation	14 /64 (21.88%)
	Fistula formation	None
Large bowel involvement (19 patients)	Obstruction	2/19 (10.52%)
	Perforation	None
	Fistula formation	None

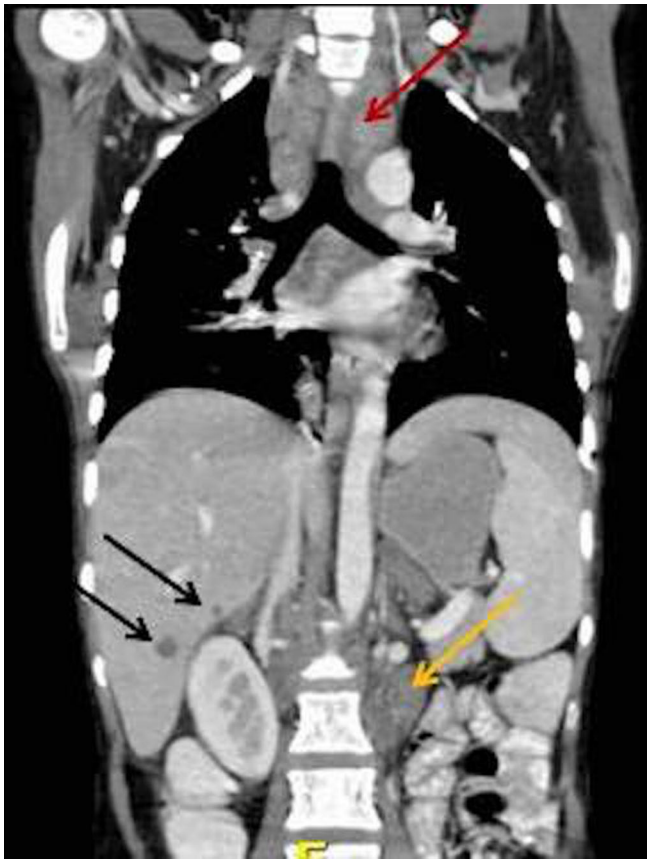

Fig. 5. Coronal CECT image showing well-defined hypodense hypoenhancing lesions in liver (black arrows) with associated enlarged necrotic conglomerated retroperitoneal (yellow arrow) and mediastinal nodes (red arrow) in disseminated tuberculosis.

Fig. 6. Axial CECT showing hypodense hypoenhancing lesion in the spleen which suggests splenic abscess with few hepatic granulomas and a peripancreatic necrotic node.

or acute on chronic with associated constitutional symptoms like fever, loss of weight, and appetite. In our series, the commonest presenting symptom of ATB was abdominal pain (78.1%) followed by constitutional symptoms like fever (42.9%), loss of appetite, and loss of weight (29.5% each). Constipation (28.5%), vomiting (41%), abdominal distension (23.8%), obstipation (1%), and diarrhea (8.6%) were predominant symptoms in bowel involvement. All patients presenting with acute abdomen had bowel involvement. Isolated solid organ involvement was seen in only 3 (2.8%) patients, whereas it was most commonly seen in combination with either peritoneal or bowel involvement. These patients presented with predominantly abdominal pain and constitutional symptoms. C Bolukbas evaluated clinical presentation of ATB and found abdominal pain (28.4%) to be the commonest symptom followed by abdominal distension (26.1%) and diarrhea (17%) [7]. Similarly, Sinan et al. analyzed features of abdominal TB in 49 patients and found abdominal pain to be the most common presenting symptom (75.5%) followed by constitutional symptoms like fever (65.3%) and loss of weight (36.7%) [8].

Peritoneum

Peritoneal TB presents as (1) 'Wet type' with free or loculated ascites. (2) 'Dry plastic' with mesenteric thickening, caseous lymph nodes and fibrous adhesions. (3) 'Fibrotic fixed' with mass formation of omentum and matting of bowel loops with cocooning [2, 9, 10]. Since there is a significant overlap in these types, this classification in rarely used.

We found peritoneal involvement in a cumulative 77.14% of patients, thus being the commonest presentation in our series. This is in accordance to the study done by Sinan et al. who found peritoneal involvement as the most common presentation of ATB (77.5%) [8].

Na-ChiangMai et al. [11] studied CT findings of peritoneal TB in 17 patients and found ascites to be present in all patients, omental involvement was seen in 88% of the patients, the most common type being smudged pattern (82%), with omental caking noted only in one patient (6%). Peritoneal thickening was noted in 88% patients; smooth uniform thickening being the most common pattern (76%) followed by irregular thickening (12%). None of their patients show nodular peritoneal implants. In our series, we studied 81 patients of ATB with peritoneal involvement. Ascites was noted in 49.38% of these cases, being low volume in majority of these patients(55%). Peritoneal thickening was noted in 28.4% of the patients with peritoneal TB, smooth thin peritoneal enhancement being the most common pattern (86.95%), followed by enhancing non-calcified peritoneal nodules (13.04%); none presenting with large peritoneal masses. Omental involvement was noted in 27.16% of

Fig. 7. (**A**) Axial CECT image showing hypodense well-defined mildly enhancing lesion in the left adrenal gland showing punctate areas of calcification within (red arrow) (**B**) Another patient showing a large hypodense well-defined mildly enhancing lesion in right adrenal with no calcification (red arrow). Associated periportal and peripancreatic necrotic nodes were seen (yellow arrow) (**C**) Coronal CECT image showing bilateral adrenal lesions (red arrows).

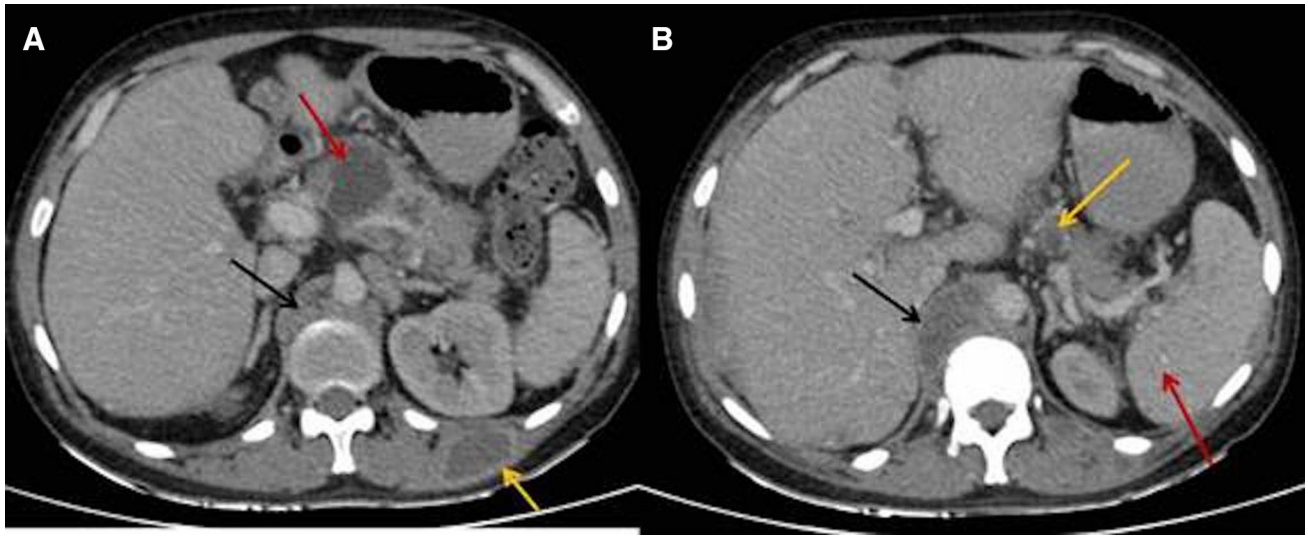

Fig. 8. (**A**) Axial CECT showing well-defined peripherally enhancing lesion in pancreas (red arrow) with pre/paravertebral collection (black arrow) and another well-defined peripherally enhancing collection in the subcutaneous plane (yellow arrow) which were associated with osteolytic vertebral lesions (**B**) Same patient showing peripancreatic necrotic node (red arrow) with pre/paravertebral collection (black arrow) and calcified splenic granuloma (yellow arrow).

these patients, with the commonest being smudged pattern (50%), followed by omental nodules (40.9%) and omental caking (9.09%).

The common differentials of diffuse peritoneal thickening are pyogenic peritonitis, peritoneal metastases, or primary peritoneal mesothelioma. Thicker nodular peritoneal enhancement, macronodules, or larger peritoneal deposits which may cause solid organ scalloping with or without ascites suggests a neoplastic etiology [11, 12]. Omental thickening with caking may also be seen with peritoneal carcinomatosis, with primary neoplasms like ovary or gastrointestinal tract. However, absence of these primaries and younger age suggest abdominal tuberculosis. Malignant primary peritoneal mesothelioma, may present with large confluent masses or nodular or diffuse peritoneal thickening with or without ascites. It can cause scalloping of, or a mass effect on, adjacent abdominal organs [12, 13]. Pyogenic peritonitis usually presents with a shorter disease course and more florid symptoms.

Lymphadenopathy

Tubercular lymphadenopathy is more commonly associated with bowel involvement than peritoneal or visceral TB [14, 15], with the most common sites of involvement being mesenteric, upper paraaortic, periportal, and peripancreatic. It can be explained by the lymphatic drainage of the ileocecal, ileal, right colonic, and jejunal regions. TB lymphadenopathy presents in various patterns as described by Pombo et al [16]. as follows: (a) peripheral rim enhancement with hypodense centers,

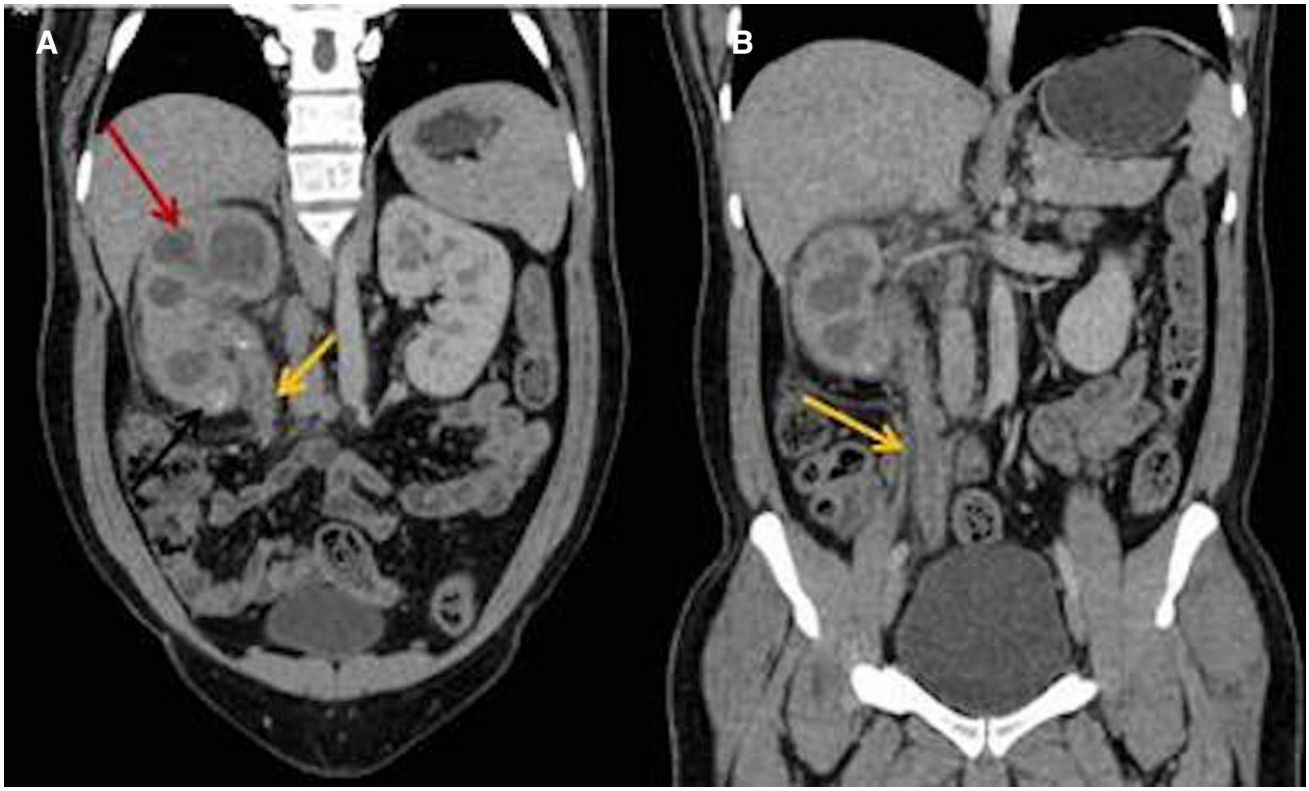

Fig. 9. (**A**) Coronal CECT image showing non-functioning right kidney with caliectasis (red arrow) and focal parenchymal calcifications (black arrow) and urothelial thickening in the pelvis and proximal ureter (yellow arrow) (**B**) Same patient showing diffuse long segment urothelial thickening in the right ureter with foci of wall calcification.

(b) inhomogeneous enhancement, (c) homogeneous enhancement, (d) non-enhancing nodes, (e) conglomerate lymph node masses with areas of necrosis secondary to perinodal inflammation, (f) increased number (3 in one CT section) of normal sized or mildly enlarged mesenteric nodes of homogeneous density and (g) calcified lymph nodes. These patterns of involvement follow a spectrum from early exudative to caseous to late fibrocalcification phases.

In our series, the commonest pattern noted was enlarged necrotic nodes (81.6%) with conglomerate nodal masses seen in 26.6% of the patients, homogenously enhancing nodes seen in 18.4% patients, and calcified nodes seen in 26.6% patients; however, isolated calcified nodes were not seen in any patient with active ATB. Most common sites of involvement were mesenteric, periportal, peripancreatic, and upper paraaortic regions, while only patients with disseminated TB showed simultaneous involvement of iliac (6.67%) and inguinal nodes (1.67%).

Common differential of necrotic abdominal lymphadenopathy is metastases from abdominal primary neoplasm, with the site of involvement corresponding to the primary neoplasm. Lymphomas and leukemias usually present with homogenously enhancing enlarged nodes; however, they may show necrosis post treatment. Other conditions which may present with necrotic nodes are pyogenic infections, inflammatory bowel disease, or Whipple's disease [15, 17]. Zhang et al. [18] found that leukemia predominantly showed homogeneously enhancing nodes (78.9% for acute myeloid leukemia and acute lymphocytic leukemia, 87.5% for chronic lymphocytic leukemia) while tuberculosis showed necrotic nodes. Also, involvement of lower paraaortic (30.9% for tuberculosis, 63.2% for acute leukemias, and 87.5% for chronic lymphocytic leukemia) and inguinal nodes (9.1% for tuberculosis, 57.9% for acute leukemias, and 53.1% for chronic lymphocytic leukemia) was more frequently seen with the prior. For the diagnosis of tuberculosis, peripheral enhancement pattern had a sensitivity of 78.2%, a specificity of 100%, and an accuracy of 88.7%. For the diagnosis of leukemia, homogeneous enhancement pattern had a sensitivity of 84.3%, a specificity of 94.5%, and an accuracy of 89.6%. Pongpornsup et al. [19] found that mesenteric and periportal lymph nodes were involved more often in patients with tuberculosis while iliac and inguinal lymph nodes were involved more often in patients with lymphoma. Peripheral enhancement was seen significantly more often in tuberculous lymphadenopathy, whereas homogeneous enhancement was found more often in lymphoma.

Calcified nodes were seen in 26.6% patients; however, isolated calcified nodes were not seen in any case of active abdominal TB. Differentials of calcified nodes are post-treatment lymphoma and seminomatous germ cell tumors, nodal metastases from colorectal, breast, bladder, and ovarian cancers [20].

Bowel involvement

Commonest site of bowel involvement by tuberculosis is small bowel, predominantly the ileocecal region [10, 21–24]. This is postulated to be due to various factors like stasis, presence of abundant lymphoid tissue, increased rate of absorption at this site, and closer contact of the bacilli with the mucosa [25–27]. The most common pattern of bowel involvement is focal or segmental regular, symmetric, and homogenous enhancing wall thickening without bowel stratification [28]. Hypertrophic form of bowel involvement may lead to asymmetric bowel wall thickening. Common differentials of small or large bowel wall thickening are neoplastic, infectious, inflammatory, or ischaemic conditions. Neoplastic lesions most commonly show focal irregular and asymmetric wall thickening with heterogeneous enhancement and rarely may present with focal regular and symmetric involvement [28]. Regional lymphadenopathy and distant metastases, if present, support the diagnosis. When involving the ileocecal region, adenocarcinomas do not usually cross the IC junction, while lymphomas do. However, lymphoma presents with greater degree of wall thickening with or without aneurysmal dilatation. Inflammatory, other infectious, and ischemic diseases usually present with segmental or diffuse wall thickening with peri-enteric inflammatory changes being disproportionately more severe than the degree of wall thickening. [29–31] Crohn's disease (CD) shows uniform thickening of the bowel wall with mural stratification, comb sign, single or multiple strictures, skip lesions, mesenteric fibrofatty proliferation, and complications such as mesenteric abscesses and fistulae which are more common in CD. Ulcerative colitis shows involvement of predominantly large bowel with long segment continuous involvement, loss of haustrations, and pericolic inflammatory changes. Mucosal changes are not well evaluated on CT, though inflammatory pseudopolyps may be seen if large.

In our series, bowel involvement was noted in a cumulative of 62.85% patients, with small bowel involvement in 96.97% (64/66) of these patients; the commonest site of involvement being the ileocecal region (73.43%). The commonest pattern of bowel involvement was homogenous circumferential symmetric bowel wall thickening without bowel stratification with mild luminal narrowing. Complications were noted in the form of obstruction (39%), perforation (3.1%), and cocoon formation (21.8%). Large bowel involvement was noted most commonly in association with small bowel disease with only 2/66 patients (3%) presenting with isolated large bowel disease. Complication in the form of large bowel obstruction was noted in 2/19 patients (10.5%).

Esophageal tuberculosis is rare, and is usually due to extrinsic compression at the level of the carina from lymphadenopathy [10, 32]. In our series, we found one case of esophageal tuberculosis presenting with esophago-mediastinal fistula caused due to extrinsic compression by necrotic subcarinal nodes. Gastric tuberculosis may present as ulcerative lesions along the lesser curvature and pylorus, hypertrophic variety, multiple miliary tubercles, or pyloric stenosis in late stages which may be associated with a sinus or fistula or lymphadenopathy[33]. No case of gastric tuberculosis was however noted in our study.

Solid organs

Isolated visceral TB is rare and is usually seen as a part of disseminated tuberculosis. Liver and spleen are the primary sites of involvement with the various radiological patterns of involvement being microabscesses (< 2 cm), macronodular abscesses (> 2 cm) ,or organomegaly (infiltrative) with calcified granulomas which are visible in the late-stage disease or after healing[34–36]. Other rare patterns of hepatic tuberculosis are tuberculous cholangitis or serohepatic tuberculosis[34]. In our series, liver involvement was noted in 14 patients (13.33%) which presented most commonly as multiple microabscesses in 5/14 (35.7%) patients. Calcific granulomas were noted in 9/14 (64.2%) patients with active ATB, which represent previous subclinical infection since our country has high prevalence of TB. None of the patients presented with macroabscess, this being a rare presentation which mimics liver abscess or hepatic neoplasms. Splenic involvement was noted in 17 patients (16.2%), being single macroabscess in 2/17 (11.7%), multiple microabscesses in 11/17 patients (64.7%), and calcified granulomas in 4/17 patients (23.5%). The common differentials of hepatosplenic tuberculosis include metastases, lymphoma, fungal infections such as histoplasmosis and sarcoidosis [9].

Lam et al reported adrenal involvement in up to 6% of patients with active tuberculosis, with most of them showing bilateral disease [37]. In our series, adrenal involvement was noted in 4.7% patients, being bilateral in 3/5 patients (60%) and unilateral in 2/5 patients (40%). Commonest presentation was well-defined hypodense hypoenhancing adrenal lesions, with two showing punctate foci of calcification. The radiological differential diagnosis includes metastasis, lymphoma, primary neoplasm, and hemorrhage.

Pombo et al. [16] studied pancreatic TB in 6 cases and reported that pancreatic mass lesion causing focal enlargement of the gland was the most common CT finding which may be associated with enlarged necrotic

Table 3. Common features of abdominal tuberculosis

	Radiological features
Peritoneal tuberculosis	Smooth peritoneal thickening, with smudged pattern of omental infiltration and mild ascites
Lymphadenopathy	Enlarged discrete or conglomerated nodes with peripheral enhancement and central non-enhancing necrotic areas, most commonly involving mesenteric, periportal, peripancreatic, and upper paraaortic regions
Bowel involvement	Circumferential symmetric enhancing wall thickening involving terminal ileum, ileocecal junction with concomitant involvement of the cecum. Large bowel involvement is most commonly seen as a single long segment stricture, with concomitant involvement of ileocecal region.
Hepatic and splenic involvement	Most commonly present as multiple microabscesses, and is usually associated with other sites of abdominal involvement, like peritoneal or bowel TB
Adrenal involvement	Unilateral or bilateral well-defined hypodense hypoenhancing adrenal lesions, which may show punctate foci of calcification
Pancreatic involvement	Peripherally enhancing abscesses. Pancreatic TB is rare and is mostly a part of disseminated TB

lymph nodes. Pancreatic involvement was noted in 2 patients (1.9%) in our series, with both these patients showing well-defined peripherally enhancing abscesses in the pancreatic body with associated necrotic peripancreatic nodes.

Thus the most common radiological features of ATB are summarized in Table 3, which will aid the readers to correctly diagnose ATB.

Other sites of involvement

38.1% patients in our series showed concomitant involvement of other sites, the most common site of involvement being lung (11.4%). Other common sites of involvement were pleural (5.7%), bone (7.6%), and tuberculous meningitis (3.8%). 9.5% patients showed genitourinary involvement with 2.8% patients showing renal involvement, 5.7% patients with bilateral tubo-ovarian masses, and 0.9% with prostatic abscess. Abdominal tuberculosis is commonly associated with other sites of involvement, with approximately 15%–25% of these patients found to have concomitant pulmonary tuberculosis. [10, 27, 38]. Hence these patients need to be screened for synchronous involvement on the background of the clinical symptoms.

Conclusion

Abdominal tuberculosis is a perplexing disease which can pose a diagnostic challenge, especially in low prevalence areas. Accurate clinical judgment with a high index of suspicion coupled with typical radiological features can aid in timely diagnosis of ATB and hence appropriate institution of treatment. Peritoneal involvement in the form of mild ascites, smooth peritoneal thickening, and smudgy omentum, conglomerated necrotic nodes most commonly involving mesenteric, periportal, peripancreatic, and upper paraaortic regions, mildly enhancing circumferential wall thickening of ileocecal region are common presentations of ATB. Isolated visceral TB though rare, most commonly presents as multiple microabscesses in a case of disseminated TB.

Compliance with ethical standards

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Conflicts of interest None.

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