ABSTRACT
Tuberculosis (TB) infection is still common today and remains an important cause of morbidity and mortality. Abdominal TB is one of the most prevalent forms of extra-pulmonary manifestations, and collectively refers to gastrointestinal, splenic, pancreatic, hepatobiliary and abdominal lymphadenopathy involvement. The manifestation can be nonspecific, and mimics many conditions, including malignancies. Biliary involvement is extremely rare. It can directly involve or be a result of external compressions or extension from adjacent organs. Strictures can be simple or multiple and isolated or complex. Radiologically, it is difficult to exclude cholangiocarcinoma. Hepatic involvement is more common and is categorised as the miliary or isolated local type. Both can be further sub-divided into nodular or diffuse forms. The manifestations range from abscesses and tuberculosis to hepatic calcifications. Calcifications range from small isolated specks to gross calcification with or without hepatic atrophy.

The diagnosis of hepatobiliary TB (HBTB) can be difficult. Ultrasonography and computed tomography are the main radiological investigations. Endoscopic retrograde cholangiography is important in the management of biliary TB. It is often important to look for the involvement of other organs and consider the coexistence of other pathologies such as malignancies. This pictorial essay reviews some of the HBTB infections that have been encountered in our tertiary referral centre.

Keywords: bile ducts, diagnostic imaging, endoscopy, hepatic tuberculosis, strictures, tuberculoma, tuberculosis

INTRODUCTION
Tuberculosis (TB) infection is a common disease and an important cause of morbidity and mortality, especially in underdeveloped and developing nations. An estimated two billion people have latent TB, with an estimated 7–8 million new cases being detected worldwide every year. Despite the availability of effective therapy, two million affected individuals succumb to this infection annually, particularly in underdeveloped nations. Patients in immunocompromised states, such as those with human immunodeficiency virus (HIV) or acquired immunodeficiency syndrome (AIDS), are particularly susceptible to TB infections, both pulmonary and extra-pulmonary. However, in this group of patients, extra-pulmonary involvement predominates.

TB infection can affect any organ. Abdominal TB is one of the most prevalent forms of extra-pulmonary manifestations. Abdominal TB collectively refers to the involvement of the gastrointestinal tract, hepatobiliary system, pancreas, spleen, abdominal lymph nodes and other abdominal organs. Overall, the prevalence has been shown to correlate with the severity of pulmonary TB (PTB). One study showed that among those with abdominal TB, the small bowel was the most commonly affected site (33.8%), followed by the peritoneum (30.7%), large bowel (22.3%), liver (14.6%) and the upper gastrointestinal tract (8.5%). However, it is believed that the liver is affected in most cases of miliary TB.

The manifestations of hepatobiliary TB (HBTB) are nonspecific and resemble other diseases such as malignancies and infections. Nonspecific presentations
Fig. 5 Nasobiliary drainage tube cholangiogram shows multiple strictures, one located in the distal common bile duct and the others in the common hepatic ducts, with resultant common bile duct and intrahepatic duct dilatations.

that are common to all TB infections and other conditions, such as fever, weight loss and anorexia, are also common. Therefore, diagnosis can be difficult, resulting in delayed treatment. The evaluation of suspected cases can be divided into three stages. The first two stages involve clinical and radiological evaluations, and usually provide indirect evidence of the presence and location of the involvements. Confirmation is required in the more invasive third stage, where tissues samples are obtained for histological and microbiological evaluations. Radiological imaging such as ultrasonography (US) and computed tomography (CT), complemented by endoscopic evaluations such as endoscopic retrograde cholangiography (ERCP) and endoscopic ultrasonography (EUS), are the mainstay of investigations. Tissue samplings are directed by these investigations. As the involvement of other organs is common, it is particularly important to look for it.④

Knowledge and awareness of the spectrum of manifestations and investigative findings are important,
as the timely diagnosis of extra-pulmonary TB remains a challenge in some cases. This pictorial essay reviews the radiological imaging findings of proven HBTB infections encountered in our tertiary referral centre. None of our patients had concomitant HIV/AIDS.

BILIARY TUBERCULOSIS

Biliary TB (BTB) is rare, and the first case of isolated BTB was only recognised and reported in 1989. To date, less than 20 cases have been reported in the English literature. In some settings, the annual incidence of BTB has been reported to be 0.0%–0.1% of all TB infections. The pathogenesis of BTB includes direct biliary contaminations from swallowed mycobacterium, extension from adjacent affected structures and rarely, by haematogenous spread. Usually, evidence of other organ involvement is observed.

BTB can occur due to primary biliary involvement or due to compression of the biliary tree by affected adjacent organs such as affected lymph nodes or hepatic granuloma. Primary biliary involvement ranges from the involvement of small to large ducts, resulting in stricture formations. These strictures can be categorised into isolated strictures or the more common complex multiple strictures that usually involve the hila region (Figs. 1–5). Biliary involvement by hepatic granuloma tends to be associated with multiple and complex strictures (Fig. 6). These complex multiple strictures resemble primary sclerosing cholangitis, and can be difficult to distinguish from cholangiocarcinoma, regardless of whether the biliary involvement is localised or diffuse. Occasionally, other findings that may potentially lead to biliary obstructions, such as stone diseases, are also present. It is also important to consider the coexistence of underlying malignancy (Fig. 7).

Biliary involvement in patients with HIV/AIDS commonly manifests as granulomatous hepatitis, resulting in cholestatic liver enzymes. This is due to predominant small duct involvement, and imaging findings typically show hepatomegaly without many ductal abnormalities.
Apart from the nonspecific symptoms common to all TB infections, clinical presentations include obstructive jaundice, chronic abdominal pain, hepatomegaly, splenomegaly and even complications of chronic liver diseases. Ascites and other abdominal symptoms may be present if there is concomitant peritoneal or intestinal involvement. Prolonged biliary obstruction can lead to secondary biliary cirrhosis.
Imaging of the biliary tree can be performed with US, CT, ERCP, magnetic resonance (MR) or magnetic resonance cholangiopancreatography (MRCP) imaging. All imaging modalities have their own advantages and usually complement one another. As the findings are often non-diagnostic, the main aim is to acquire tissue for diagnosis. EUS is now becoming an important diagnostic and therapeutic tool. ERCP has the advantage of allowing the placement of biliary stents to decompress the obstructed systems, in addition to bile and tissue samplings. More invasive modalities, such as percutaneous transhepatic cholangiography (PTC) or surgery, may be required. Imaging findings consist mainly of biliary dilatations, strictures and other concomitant findings such as hepatic calcifications or tuberculoma. In isolated biliary involvement, imaging typically shows biliary dilatation proximal to the strictured area, a finding that is common to biliary obstructions of other aetiologies. In complex involvement, imaging may only show localised dilatations or no dilatations at all. However, it is important to consider TB if there are findings of hepatic calcifications.

Management includes biliary drainage and standard anti-TB therapy. Isolated strictures can be easily managed with biliary stenting. However, these strictures may be fibrotic and tight. Sequential placement of multiple plastic stents has been shown to be effective, as the stents serve as biliary drainage and a dilator. The management of multiple or complex strictures is more challenging and requires combination therapies that are endoscopic, percutaneous or surgical.

**HEPATIC TUBERCULOSIS**

Hepatic TB (HTB) is rare but more common than BTB. As in all TB infections, the involvement of other organs is common. Despite the scarcity of reports in the literature, HTB is reported to occur in 50%–80% of patients who are dying of PTB. In autopsy studies, this rate approaches 90%. Therefore, hepatic involvement is possibly under-diagnosed and under-reported in clinical practice. It has also been reported that concomitant splenic involvement is common in patients with HTB, particularly in patients with HIV/AIDS. However, in our local setting, splenic involvement is uncommon, and to date, we have not encountered any cases.

HTB manifestations can be broadly divided into two types: the more common miliary type and the less common local type. Each of these can be further divided into diffuse and nodular types. The pathogenesis of miliary manifestations is due to haematogenous spread of the mycobacterium via the hepatic arteries, resulting in granulomatous hepatitis, and this is characterised by diffuse hepatic involvement. The patients usually show evidence of miliary PTB. This manifests as diffuse

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**Fig. 11** CT image shows hepatic calcifications in the atrophic right lobe and ductal dilatation (arrow).

**Fig. 12** (a) CT image shows fine calcifications in a young man with previous hepatic involvement. The type of calcifications is finer (in contrast to the patient in Figs. 9 & 10). (b) CT image of an elderly man who presented with weight loss, fever, anorexia and abdominal pain shows hepatic calcifications (localised form) in segments 4 and 5. This patient was diagnosed with active TB of the ascending colon and was managed with anti-TB treatment, but his disease was complicated by multiple intra-abdominal sepsis with resultant portal vein thrombosis and gastric variceal bleeding. The patient eventually died of sepsis and variceal bleeding.
hepatic enlargement and abnormal cholestatic liver function test with disproportionate elevated serum alkaline phosphatase compared to serum bilirubin. Liver histology usually reveals multiple granulomas with or without caseation. Radiological imaging usually does not reveal any ductal dilation despite the cholestatic liver function test. This is due to predominant small duct disease.

In the acute stages, hepatic imaging may show multiple small lesions resembling abscesses or metastases (Fig. 8). Healing of these granulomas can lead to calcifications. Therefore, the presence of calcification usually indicates healed lesions, and biopsy of these lesions is often non-contributory and of a low yield. However, it is important to consider the reactivation of latent infections in patients with imaging findings that are consistent with previous TB infection (Fig. 9). Glandular atrophy or associated duct dilatations (Figs. 10 & 11) may also be observed. The patterns of calcifications differentiate the diffuse from the nodular form (Figs. 9 & 12). Patients are often treated for miliary TB without many symptoms due to hepatic involvement. However, acute liver failure has previously been reported.\(^{(1)}\)

The local type occurs through the spread of the mycobacterium via the portal vein from the intestine. This explains the common association of hepatic involvement in patients with bowel TB. In contrast to the miliary type, there is less evidence of pulmonary involvement. These lesions may appear as abscesses, space occupying lesions that resemble either hepatocellular carcinoma or metastatic diseases (Figs. 13 & 14).

Both the miliary and local types are more common in patients with HIV/AIDS. The radiological manifestations resemble those of patients without HIV/AIDS. The management of HTB is mainly medical, with standard anti-TB therapy unless there is concomitant ductal involvement. In cases of concomitant biliary involvement, biliary decompression will be required.

**EXTRA-HEPATOBILIARY TB INVOLVEMENT**

As the involvement of other organs is common, it is particularly important to look for the presence of TB infection in other organs, especially in the chest. CT imaging, bronchoscopy and bronchoalveolar lavage may be required, as routine radiography may not be sensitive enough. It is necessary to search for the presence of gastrointestinal, peritoneal and omental involvement in patients suspected to have HBTB.

**CONCLUSION**

This pictorial essay underscores the varied manifestations of HBTB and the importance of knowledge about it due to its different manifestations and investigative findings. As the treatment for TB infections is standardised, timely and accurate diagnosis is vital. Suggestive symptoms, such as anorexia, abdominal pain, weight loss, fever and obstructive jaundice in patients with risk factors, laboratory investigation findings of elevated erythrocyte sedimentation rates, anaemia and hypoalbuminaemia, should heighten suspicion for HBTB in patients presenting with hepatobiliary problems. Common
findings include calcifications, mass lesions that resemble abscesses or tumours, dilated ducts that can be singular, simple, multiple or complex. Evaluations for the possible involvement of other organs are important. A proposed algorithm for the investigations of patients with suspected HBTB is shown in Fig. 15.

REFERENCES
Question 1. Regarding hepatobiliary tuberculosis:
(a) Hepatobiliary tuberculosis is a part of abdominal tuberculosis. ☐ ☐
(b) Severity of involvement is not correlated with pulmonary involvement. ☐ ☐
(c) Manifestations are nonspecific and may result in a delayed diagnosis. ☐ ☐
(d) Evaluation can be divided into three stages. ☐ ☐

Question 2. Regarding biliary tuberculosis:
(a) Stricture formation is a common manifestation. ☐ ☐
(b) Strictures are usually isolated. ☐ ☐
(c) Biliary strictures can resemble cholangiocarcinoma or primary sclerosing cholangitis. ☐ ☐
(d) Prolonged stenting alone is an acceptable therapy. ☐ ☐

Question 3. Regarding hepatic tuberculosis:
(a) Hepatic involvement is as common as biliary involvement. ☐ ☐
(b) Hepatic involvement has been reported to occur in up to 90% of patients who are dying of pulmonary tuberculosis. ☐ ☐
(c) Hepatic involvement can be broadly categorised as miliary or local type. ☐ ☐
(d) The miliary type is often associated with venous spread. ☐ ☐

Question 4. In the evaluation of hepatobiliary tuberculosis:
(a) Preliminary investigations provide useful clues to the line of investigation. ☐ ☐
(b) Definitive diagnosis does not require isolation of the mycobacterium. ☐ ☐
(c) Concomitant malignancies need to be considered. ☐ ☐
(d) CT imaging is the best modality for detecting hepatic calcifications. ☐ ☐

Question 5. Regarding hepatobiliary tuberculosis:
(a) In biliary involvement, ultrasonography may be normal in early involvement. ☐ ☐
(b) Early hepatic involvement may resemble hepatic abscess. ☐ ☐
(c) Hepatic atrophy is not a complication of hepatic tuberculosis. ☐ ☐
(d) Secondary biliary cirrhosis is a recognised complication. ☐ ☐