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## Case report

# Imaging diagnosis of sternal tuberculosis- A report of two cases of the ancient disease with a new demeanour ☆☆☆

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## ABSTRACT

Tuberculosis is an ancient disease known to have existed even in the Egyptian civilization. It is estimated that a quarter of the world's population is already infected and 1 million will die of the disease, in the current year. Although tuberculosis may occur in any organ, extra-pulmonary tuberculosis accounts for 10%-14% of all cases of tuberculosis. Skeletal involvement comprises only 1 to 5 % of all types of tuberculosis and the most frequently involved site in the skeleton is the vertebral column, amongst the skeletal structures, the sternum is involved very rarely, accounting for just 1-2% of all bone and joint tuberculosis. We report two cases of sternal tuberculosis, and enumerate the imaging appearances seen at ultrasound, CT and MRI and also highlight a relatively underemphasised complication of mediastinal involvement due to a retrosternal abscess. Rapid diagnosis by imaging studies led to early treatment and prevented catastrophic consequences of diffuse mediastinitis. Awareness of tuberculosis and its atypical skeletal manifestations is important not only in developing countries with endemic disease, but also in developed countries, due to its resurgence by the HIV epidemic and also because extensive in-

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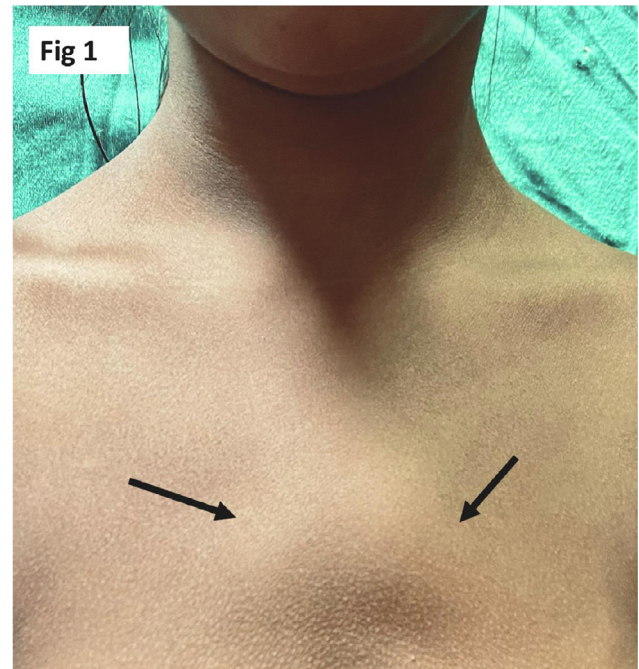
ternational travel and transcontinental migration continues to facilitate greater disease transmission.

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Tuberculosis is an ancient disease known to have existed even in the Egyptian civilization [1]. It is estimated that a quarter of the world's population is already infected and one million will die of the disease, in the current year [2]. Although tuberculosis may occur in any organ, it is more frequently a disease of pulmonary parenchyma, and extra pulmonary tuberculosis, accounts for 10%-14% of all cases of tuberculosis [3,4]. Skeletal involvement comprises only 1 to 5 % of all types of tuberculosis and the most frequently involved site is the vertebral column, followed by large weight bearing joints [3,5,6]. Even amongst the skeletal structures, sternal involvement accounts for only 1-2% of all bone and joint tuberculosis [7,8]. Most of the reported cases of this rare entity, are in adult patients and very few in children [5,7-16]. We report two cases of sternal tuberculosis both in immunocompetent patients, the first in a 7 year old child and the second in an adult male. We describe the imaging appearances seen at ultrasound, CT and MRI and also highlight a relatively underemphasised complication of mediastinal involvement in the form of retrosternal abscess, which was seen in both our patients. Rapid diagnosis by imaging studies led to early treatment and prevented impending catastrophic consequences of diffuse mediastinitis. Awareness of tuberculosis and its atypical skeletal manifestations is important not only in developing countries with endemic disease, but also in developed countries, due to its resurgence by the HIV epidemic and also because extensive international travel and transcontinental migration continues to facilitate greater disease transmission.

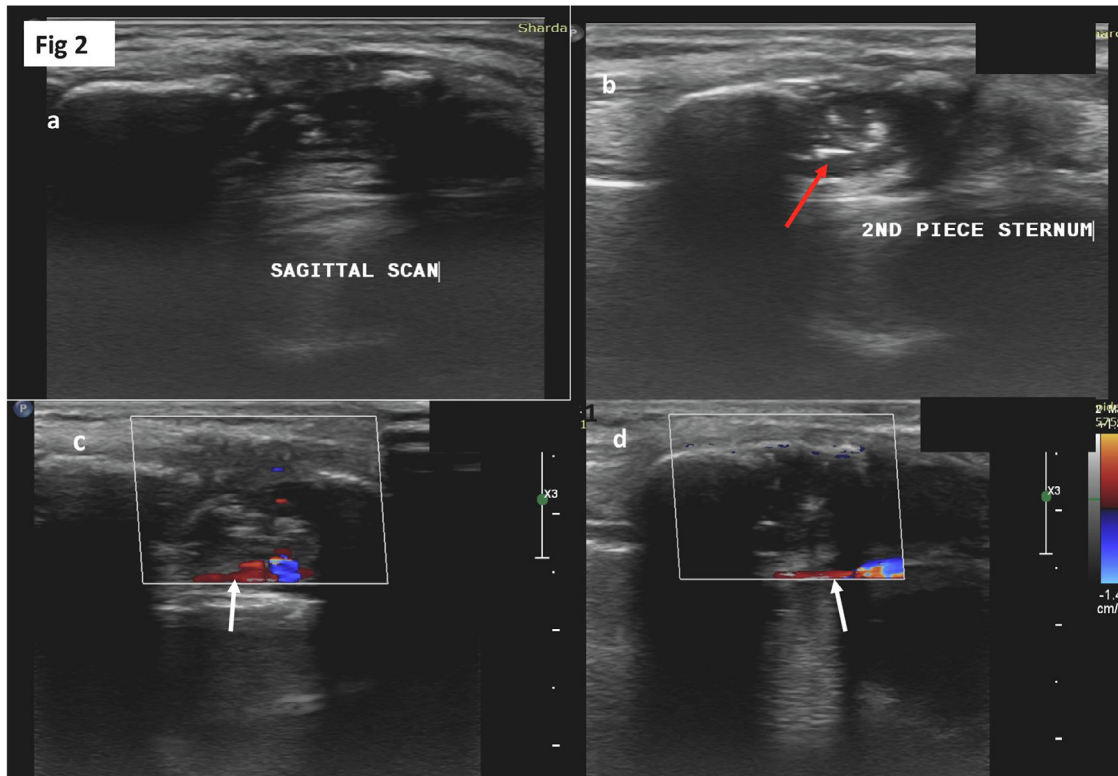
### Case report 1

A 7 year old girl of poor socio-economic stratum was brought to the hospital with a four months history of intermittent low grade fever and a progressively enlarging painless swelling, over the sternal region. There was no history of cough or weight loss. On physical examination, there was a localised swelling over the upper sternal region, which measured approximately 2 cm in diameter (Fig. 1). However there was no tenderness and the skin colour and local temperature were normal over the involved area. The hematology parameters showed lymphocytes were 40% and ESR was raised 36 mm / hour (reference range 0-15 mm / hour). The biochemistry parameters including blood sugar were within normal range. A Mantoux skin test and an ultrasound evaluation were requisitioned, with a clinical suspicion of "cold abscess". The Mantoux skin test reading revealed a 12 by 12 mm induration after 72 hours. Ultrasound examination using a high frequency transducer over the involved region, revealed a hypoechoic collection with ill-defined margins, located in the subcutaneous plane. There was complete lysis of underlying

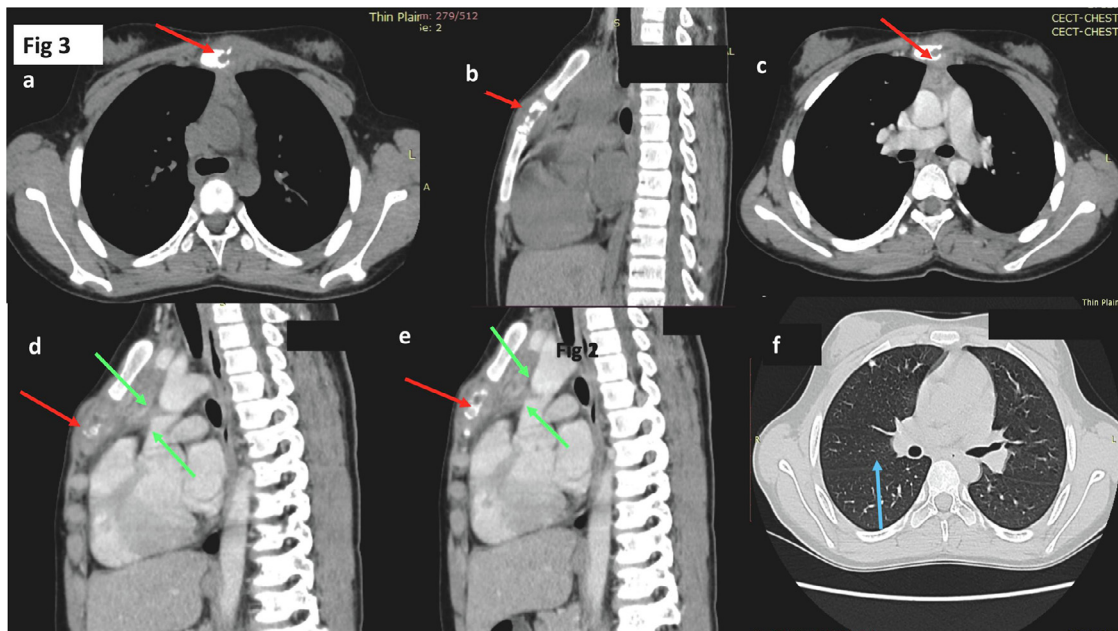


**Fig. 1 – Case 1. Clinical appearance of the 7 year old girl shows a midline swelling in the sternal region (black arrows). (Color version of the figure is available online.)**

bone, through which the collection was tracking posteriorly into the retrosternal compartment. The retrosternal collection showed multiple echogenic foci and slightly increased vascularity (Fig. 2). Thereafter, a CT evaluation was performed as a non-contrast and contrast enhanced study, using care dose and abdominal shielding. The examination revealed permeative destruction in the upper part of sternal body along with a lytic lesion and extruded sequestrum. The soft tissues surrounding the external surface of the involved bone were edematous and were communicating with the underlying retrosternal component through eroded bone. On post contrast study, the retrosternal component was well margined and had a faint rim enhancement and was abutting the great vessels. The retrosternal collection extended superiorly to the superior margin of the manubrium and inferiorly till the upper surface of the right atrium. Additionally a subpleural calcified nodule was seen in the right middle lobe (Fig. 3). The MRI study revealed that the soft tissue inflammation was hypointense on T1W and hyperintense on T2W and STIR sequences. An altered signal was seen in the upper half of the sternal body, which was hypointense on T1W and hyperintense on T2W and STIR sequences (Fig. 4). The retrosternal collection as seen on CT, was found to be communicating with the superficial

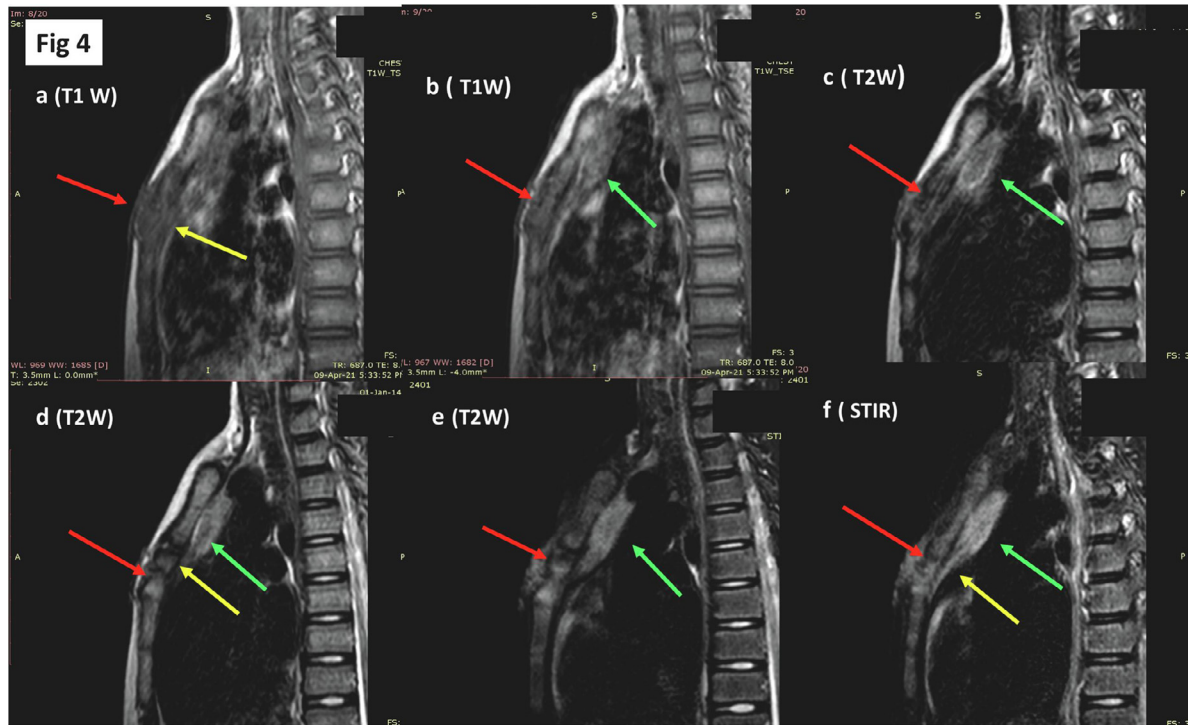


**Fig. 2** – Case 1. Ultrasound evaluation of the sternal swelling in the 7 year old girl showed a poorly margined hypoechoic collection in the superficial tissue (blue arrows, a), which was tracking into the retrosternal compartment through the underlying bone defect (yellow arrow, a). The retrosternal collection showed multiple echogenic foci (red arrow, b) and lowgrade peripheral vascularity (white arrows, c and d). (Color version of the figure is available online.)



**Fig. 3** – Case 1. Thoracic CT scan in the 7 year old girl, revealed permeative destruction with a lytic lesion and extruded sequestrum in the upper part of sternal body (red arrows, a -e). The involved bone had an overlying soft tissue component, which was connected through lytic bone, to a large retrosternal collection (green arrows, d & e). The retrosternal component which showed a faint post contrast enhancement with a “rim sign” (green arrows, d,e) was extending from the superior margin of the manubrium till the superior surface of the right atrium. The lung windows revealed a calcified nodule in subpleural location of right middle lobe (blue arrow, f). (Color version of the figure is available online.)





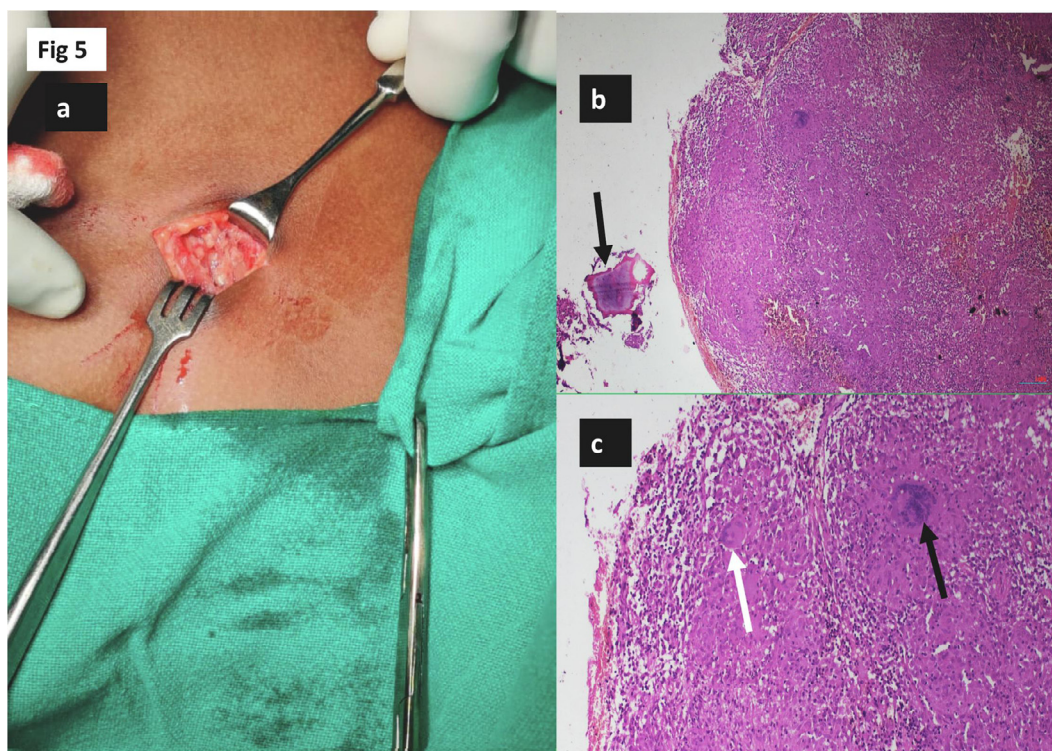
**Fig. 4** – Case 1. MRI thorax in the 7 year old girl, showed a soft tissue collection over the upper sternal body, connected through diseased bone with a large retrosternal component. The superficial collection was hypointense on T1W, mixed intensity on T2W, and hyperintense on STIR sequences (red arrows, a- f). The underlying bone showed irregular margins and its signal intensity was hypointense on T1W, mixed intensity on T2W and hyperintense on STIR sequences (yellow arrows in a, d & f). The retrosternal collection was extending from the upper part of manubrium to the superior surface of the right atrium. The collection was of mixed signal intensity on T1W and T2W and hyperintense on STIR sequences (green arrows b-f). (Color version of the figure is available online.)

collection and had a mixed intensity on T1W and was hyperintense on T2W and STIR. (Fig. 4). An imaging diagnosis of sternal tuberculosis with retrosternal abscess, following old healed pulmonary tuberculosis, was arrived at. Following an ultrasound guided aspiration which yielded a dry tap, a debridement biopsy was performed which yielded thick granulation tissue (Fig. 5). The tissue was subjected to histopathology as well as Cartridge based nucleic acid amplification test (CB-NAAT). The histopathology examination revealed multiple epithelioid granulomas and Langhan's giant cells suggestive of tuberculosis (Fig. 5). The CBNAAT confirmed the diagnosis of tuberculosis and rifampicin resistance was simultaneously excluded. HIV testing was performed prior to initiating anti tubercular therapy and was found negative. An initial four drug anti-tubercular "Intensive Phase regime" for two months duration was prescribed, which comprised of Isoniazid 150mg(5mg/kg), Rifampicin 300mg(10mg/kg), Ethambutol 800mg(25mg/kg), Pyrazinamide 500mg(15mg/kg), along with adequate counselling. Based on previous clinical experience, active intervention for the mediastinal collection was decided against and a fortnightly clinical-imaging surveillance was advised. The patient's general condition improved gradually within three weeks, although imaging resolution lagged be-

hind the clinical recovery. The patient is on teleconsultation follow up due to the COVID pandemic and is recovering satisfactorily.

## Case report 2

An adult male aged 42 years, of an economically poor strata reported to the hospital with a gradually enlarging, painless swelling over the sternal region since 3 months, accompanied by intermittent low grade fever and weight loss. On examination there was a soft swelling over the upper part of sternal body, which was fixed to the underlying bone. The local temperature was normal with slight discoloration of overlying skin (Fig. 6). The clinical appearance suggested a cold abscess for this patient as well. The routine laboratory parameters documented a mild lymphocytosis and monocytosis of 19% and 10% respectively, ESR of 35 mm/hour (reference 0-20mm/hour) and normal blood sugar levels. The Mantoux test showed a 14 × 13 mm induration after 72 hours. Ultrasound evaluation was requisitioned, which revealed a poorly encapsulated hypochoic collection in the subcutaneous plane



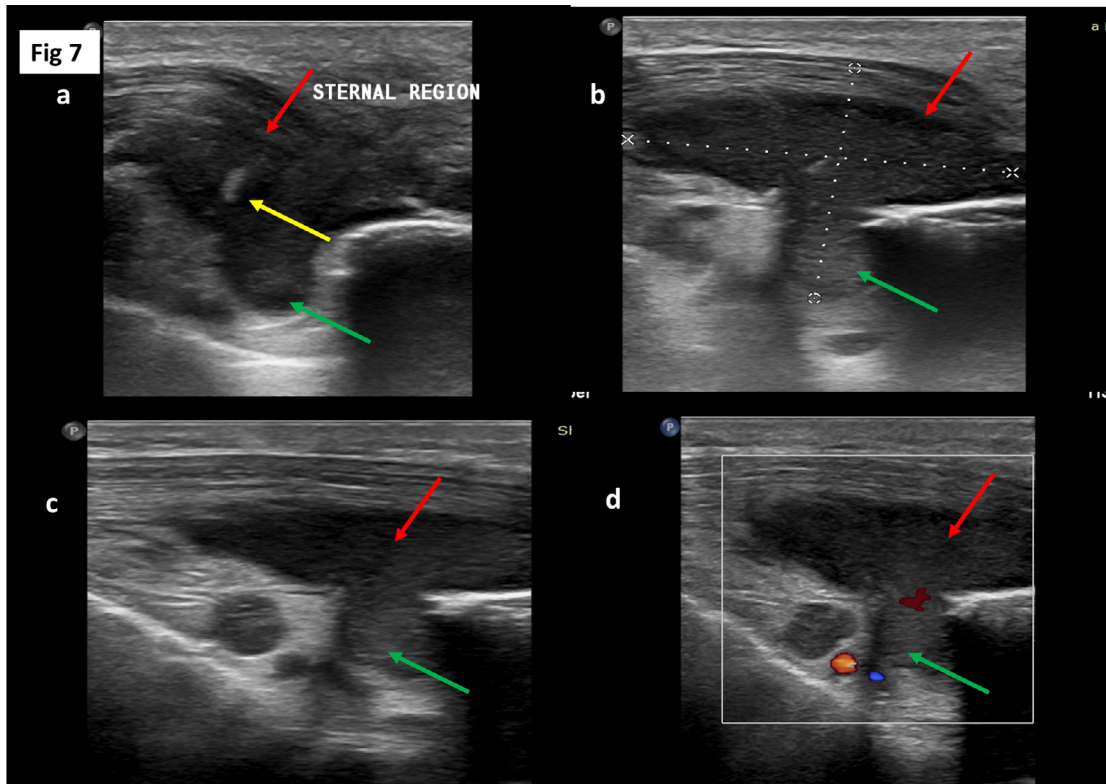
**Fig. 5 – Case 1.** Shows the post debridement surgical wound in the 7 year old girl (black arrows, a). The histopathological evaluation of the debrided specimen, using H& E stain, showed a bony fragment (black arrow, b). High power examination showed epithelioid cell granuloma (black arrow, c) and Langhan's giant cell (green arrow, c) all favouring a diagnosis of bone tuberculosis. (Color version of the figure is available online.)



**Fig. 6 – Case 2.** Clinical appearance of the 42 year old male, shows a swelling in the manubrial region located in right paramedian plane. (Color version of the figure is available online.)

overlying manubrial region of the sternum. The collection which measured  $3.7 \times 2.6$  cm, had low level echoes with few echogenic foci. The underlying bone appeared normal, however, the collection seemed to track posteriorly through the soft tissues into the retrosternal compartment. The retrosternal collection revealed homogeneously low level echogenic contents. Colour Doppler evaluation showed a low grade vascularity around the abscess, indicating a chronic low grade inflammation (Fig. 7). A CT scan was performed (only a non-contrast study, due to financial constraints of the patient), the appearances of which corroborated with the ultrasound findings. There was a well-defined soft tissue mass like lesion overlying the manubrium sterni, with surrounding fat stranding, which was communicating with a large retrosternal collection in the right anterior mediastinal location. The retrosternal component had a central hypodensity and was posteriorly abutting the aortic arch and the superior vena cava. The bone windows showed permeative lysis on the posterior surface of the sternal body. On lung windows, apical regions of both lungs showed fibro-nodular opacities (Fig. 8). MRI evaluation revealed the soft tissue swelling to be hypointense on T1W and hyperintense on T2W and STIR sequences (Fig. 9). There was a well-defined track, connecting the superficial soft tissue collection with the retrosternal component, which was hyperintense on T2W and STIR sequences. There was a well marginated retrosternal collection, which circumferentially encased the manubrium on its superior, posterior and



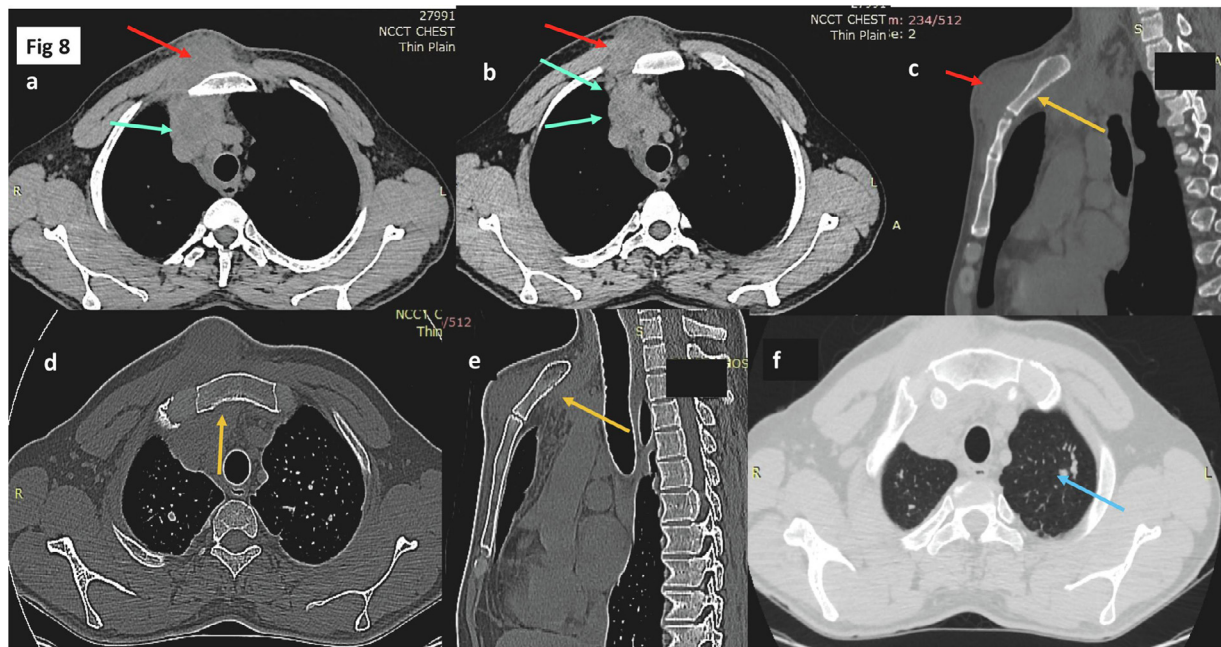


**Fig. 7 – Case 2. Ultrasound examination over the right paracentral manubrial swelling of the 42 year old male, showed a poorly marginated hypoechoic collection in the superficial plane (red arrows, a- d) with few echogenic foci (yellow arrow, a) and a retrosternal extension along the right lateral margin of the bone (green arrows, a- d). Low grade vascularity was seen on color doppler examination (d). (Color version of the figure is available online.)**

inferior aspects. This collection was hypointense on T1W sequences mixed intensity on T2W and hyperintense on STIR sequences. The marrow of the involved bone was mildly hyperintense on T2W and STIR sequences (Fig. 9). The gamut of imaging appearances suggested a diagnosis of sternal tuberculosis involving the manubrium, with a retrosternal abscess and co-existing active pulmonary tuberculosis. An ultrasound guided Fine needle aspiration cytology (FNAC) from the soft tissue abscess, revealed acid fast bacilli, thereby confirming the imaging diagnosis of tuberculosis (Fig. 10). The tissue was subjected to a Cartridge based nucleic acid amplification test (CB-NAAT), as in the first patient, which reconfirmed the diagnosis as well as excluded rifampicin resistance. Immune suppression due HIV was excluded by ELISA tests. A four drug anti tubercular therapy comprising of Isoniazid 300mg(5mg/kg), Rifampicin 600mg(10mg/kg), Ethambutol 1000mg(25mg/kg), Pyrazinamide 1000 mg (15mg/kg) was instituted as initial intensive phase therapy. Based on previous clinical experience, active intervention for the mediastinal collection was decided against, in this patient as well and a fortnightly clinical-imaging surveillance was advised. The patient showed a significant clinical improvement in 3 weeks although the resolution at imaging was not so rapid. This patient is also on teleconsultation follow up and not visiting the hospital due to the COVID pandemic, but steadily recovering.

## Discussion

Tuberculosis, an infectious and contagious disease encountered globally, is known to have existed since the ancient civilizations, as the application of paleopathology techniques have confirmed its prevalence in almost a third of Egyptian mummies [1,17]. The disease was also well recognised in Europe through the middle ages, and it was an English physician Benjamin Marten who proposed an infectious origin for the disease in 1720 [17]. The bacillus was finally isolated and reported by Dr Robert Koch in 1882, which subsequently revolutionised the development of diagnostic and therapeutic techniques for this age old infection [17]. However, despite over a century of scientific knowledge, effective eradication of this historic, contagious disease has so far evaded mankind and this ailment which has been aptly christened as a “master masquerader”, often emerges with myriad manifestations, which never fail to surprise. The reasons for the tuberculosis pandemic prevailing for centuries are believed to be multifactorial, which include, complexity of immunological host response, non-compliance towards completing prolonged therapy, emergence of multidrug resistance strains, and surging HIV prevalence, which further provides an amicable opportunistic environment in immunologically deprived patients [6,17,18].



**Fig. 8 – Case 2.** Non Contrast thoracic CT of the 42 year old male, showed a soft tissue mass-like lesion in the superficial plane overlying the manubrium sterni with surrounding fat stranding (red arrows, a- c), underlying bone destruction and retrosternal extension of disease was also seen along the right lateral margin of the involved bone (green arrows, a, b). Bone windows showed permeative destruction on the posterior surface of the manubrium (yellow arrows c, d & e). The retrosternal component had a central hypodensity. Lung windows showed fibronodular and “tree in bud” opacities in left apical region (blue arrow, f). (Color version of the figure is available online.)

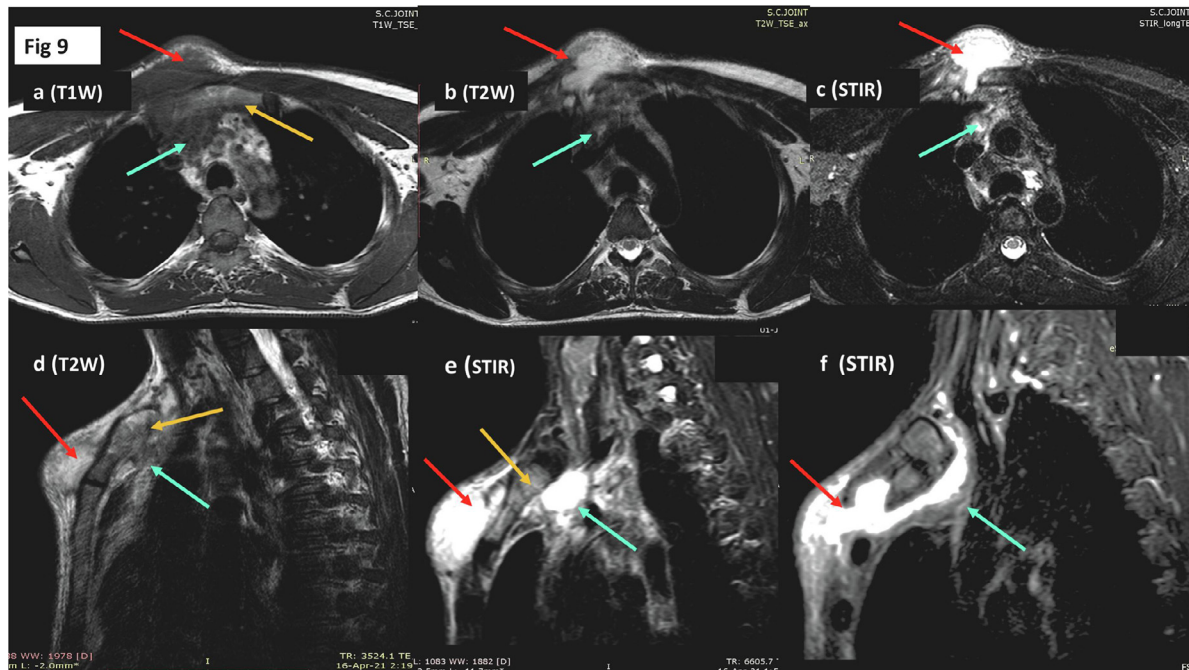
Extra-pulmonary tuberculosis, which accounts for 15-20% of all cases of tuberculosis in HIV negative patients and 40-50% of new infections in HIV positive patients, is known to be a diagnostic and therapeutic challenge [18]. Skeletal involvement comprises 10-18% of all extra pulmonary tuberculosis and most frequently affects the vertebral column, followed by the hip and knee joints [3,6]. The sternum is usually resistant to infections and if it occurs, is usually pyogenic in origin. The commonly encountered etiological agents are staphylococci or pseudomonas and are typically found in patients who have undergone sternotomy, blunt chest trauma, aggressive cardio pulmonary resuscitation or subclavian intravenous line insertion procedures [9,15]. Affliction of the sternum by tuberculosis is rare and occurs in only 0.3% of all tuberculosis [8,15]. The infection is believed to occur either by contiguous spread from lung, pleura or mediastinal lymph nodes or by haematogenous spread [9,15].

The clinical manifestations due to tubercular sternal osteomyelitis, are characteristically insidious, with pain, swelling and fistulae over the involved site, in contradistinction to a more fulminant clinical course presented by a pyogenic osteomyelitis [9]. The latter explains its delayed presentation, with latency extending to few months, as occurred in both the reported patients. Although an immunocompromised state is known to predispose to tubercular infection, both our patients were immunocompetent. Very few cases of sternal tuberculosis have been reported to occur in children and two of these, one in a 7 year old and another in a 5 year old, have both been reported from India

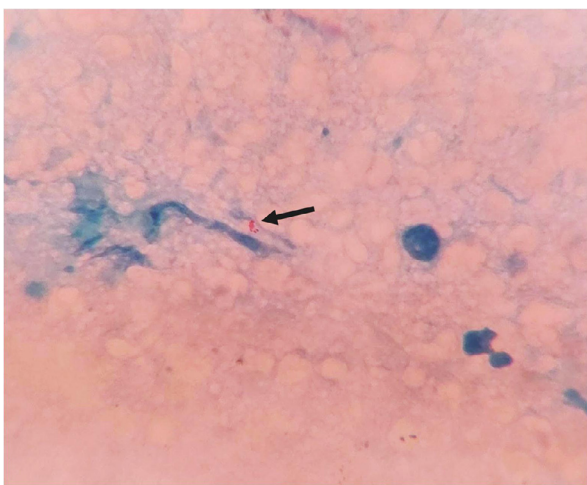
[7,13]. The first patient in this study was a 7 year old girl, the second was a middle aged adult male. Few prior studies have reported skin ulcers, discharging sinuses and fistulae, which were not seen in either of the two patients [7,12,13,16].

Imaging evaluation along with a high index of clinical suspicion led to a rapid and accurate diagnosis, paving the path towards early treatment and a reasonably rapid recovery, in both our patients. Ultrasound is the primary modality to evaluate superficial abscesses and collections, due to the current availability of high frequency transducers, which have an inherent capability of excellent soft tissue resolution. Ultrasound examination in both the patients revealed the “cold abscess” overlying lytic bone along with retrosternal extension into the anterior mediastinum. On sonography the collections were mostly hypoechoic, with poorly defined walls. Color Doppler furthered the information of chronicity by demonstrating low grade peripheral vascularity. Pyogenic abscesses on the other hand, are known to show thicker, more echogenic contents, with profuse vascularity. The role of ultrasound as a primary modality, has been highlighted in earlier studies as well [7,15]. In the present series, Ultrasound was additionally useful for guided aspiration and during the post treatment surveillance, also served as a rapid, radiation free and cost effective modality.

CT abnormalities of bone erosion, sequestrum formation and sclerosis, with adjoining soft tissue inflammation have been documented in previous reports [7-10,12,13,15]. As seen in both our patients, CT scan preferably performed as a con-



**Fig. 9** – Case 2. MRI examination thorax, of the 42 year old male, showed a soft tissue mass-like lesion with underlying bone destruction and retrosternal extension of disease around the right lateral margin of the involved bone. This soft tissue mass which had surrounding fat stranding, was hypointense on T1W sequences, moderately hyperintense on T2W and markedly hyperintense on STIR sequences (red arrow, a-f). The manubrium showed altered marrow intensity which had both hypointense and hyperintense foci on T1W and T2W sequences and was found to be hyperintense on STIR sequences (yellow arrows a,d,e). The retrosternal collection which was hypointense on T1W sequences, mixed intensity on T2W and markedly hyperintense on STIR sequences, was seen to circumferentially encase the manubrium on its superior, posterior and inferior aspects and was abutting the underlying aortic arch and SVC (green arrows, a-f). (Color version of the figure is available online.)



**Fig. 10** – Case 2. Fine needle aspiration of sternal swelling in the 42 year old male, revealed acid fast bacilli with a beaded appearance (black arrow), confirming the diagnosis of tubercular infection. (Color version of the figure is available online.)

trast study, remains invaluable as a “one stop shop”, for delineating bone erosion, sequestrae and the surrounding abscess. In both our patients, mediastinal “tracking” of the abscess, its exact extent and its effect on the vital structures was also exquisitely demonstrated at CT. The co-existing pulmonary, pleural or mediastinal lymph node as an additional focus, if present on CT, further provides corroborative evidence for the etiological agent. The first patient in this study, had a small healed, calcified nodule, while the second had active pulmonary tuberculosis revealed on CT scan.

MRI provides superior soft tissue resolution for evaluation of the extent of infection, as well as changes in the bone marrow. The MRI appearances of sternal tuberculosis were probably for the first time, described by Atasoy et al in 2002, which were reported as hypointense bone marrow on T1W and hyperintense on T2W scans [9]. The MRI appearances reported subsequently by other Investigators were almost identical to those described in the study by Atasoy et al [5]. MRI performed in both patients in the present study, similarly revealed hypointense bone and granulation tissue on T1W sequences, which was of a mixed intensity on T2W and hyperintense on STIR sequences. Although MRI was performed for completing the imaging protocol in both the patients in the present study,



in our opinion, CT provides equally adequate information for sternal tuberculosis. CT should be the preferred modality especially in resource poor countries, as it is more economical and the examination times are much shorter. Furthermore, MRI does not evidently add any clinical information beyond CT, which significantly contributes towards altering the patient management.

The diagnosis of sternal tuberculosis is almost certain, in the presence of characteristic imaging appearances described in this report, especially in the absence of a history of sternotomy and more so in endemic countries. The diagnosis can be confirmed by guided FNAC or by debridement biopsy, if the FNAC yields a dry tap. The recommended treatment is an intensive four drug treatment for two months in the initial phase, followed by three drugs for another 10-16 months, depending on the individual patient response [3]. Anti-tubercular drug therapy can be supplemented by a surgical debridement at the initial stage, if necessary. Since tubercular abscesses are known to have a typically indolent course and they are usually not actively drained. These abscesses usually resolve over 12-16 weeks with appropriate anti tubercular drug therapy. The same regime was successfully adopted in both our patients.

We have presented the clinical and multi-modality imaging features of sternal tuberculosis, which is a rare manifestation of a common disease. The clinical presentation although appearing rather benign, may however in few cases, harbour a mediastinal abscess due to retrosternal extension of disease. Ultrasound is a valuable first line investigative modality, which not only suggests the diagnosis but also serves for FNAC/ biopsy guidance and intra-treatment surveillance. CT is a “one stop shop”, which confirms sternal erosions, reveals the retrosternal abscesses and coexisting thoracic tuberculosis in lungs, pleura or mediastinal nodes. Anti-tubercular drug therapy supported by surgical debridement is the preferred management regime and usually succeeds. India and other endemic countries around the world, have launched “directly observed treatment- short course”(DOTS) regimes, along with aggressive contact tracing and testing for drug resistance, in support of the WHO global endeavour towards eradication from this ancient illness tuberculosis, by the year 2050.

## Patient consent

The authors affirm that patient consent has been obtained from both patient parties (in the regional language) for publication of the case reports on grounds of maintaining anonymity.

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