

Pulmonary tuberculosis in a captive giraffe (*Giraffa camelopardalis*)

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ABSTRACT

This study reports gross and histopathological findings in a 16-year-old pregnant female giraffe (≈13 months gestation) that died of systemic tuberculosis. Ante-mortem signs included anorexia, lethargy, weight loss, and weakness, which worsened despite supportive care. Postmortem examination revealed markedly enlarged, firm lungs studded with multiple grayish-white nodules throughout the parenchyma. Cut sections of lungs showed caseous, gritty areas consistent with chronic granulomatous inflammation. The heart was mildly enlarged with pale streaks and focal discoloration, suggesting degenerative and inflammatory changes. Histopathology of the lungs demonstrated classical granulomas with central caseous necrosis surrounded by epithelioid macrophages, Langhans-type multinucleated giant cells, lymphocytes and fibrous tissue, confirming tuberculosis. Adjacent lung tissue showed congestion and inflammatory infiltration. Cardiac sections revealed myocardial fibre degeneration, interstitial edema and mononuclear cell infiltration, consistent with myocarditis. Based on these findings, a diagnosis of disseminated tuberculosis with myocardial involvement was established. The occurrence in an advanced pregnant animal suggests that physiological stress and immunomodulation may have contributed to disease progression. This study highlights the importance of thorough necropsy and histopathological evaluation in detecting infectious diseases in wild species and emphasizes the potential for multisystem involvement in tuberculosis, complicating clinical presentation and outcomes.

Keywords: Giraffe, Granulomatous inflammation, Histopathology, Myocarditis, Tuberculosis

INTRODUCTION

Tuberculosis (TB) is a chronic granulomatous infectious disease caused by members of the *Mycobacterium tuberculosis* complex, affecting a wide range of domestic and wild animals, including large ruminants and exotic species such as giraffes^{1,2}. It represents a significant zoonotic and wildlife health concern due to its persistence in the environment, wide host range and potential for interspecies transmission at the human-animal interface^{3,4}. In wild herbivores, the disease typically progresses insidiously with vague clinical signs such as anorexia, weight loss and lethargy, often leading to delayed diagnosis and detection only during postmortem examination^{5,6}.

Giraffe (*Giraffa camelopardalis*), although generally considered relatively resistant to infectious diseases, have been reported to develop tuberculosis, particularly under captive conditions where factors such as stress, overcrowding and prolonged exposure to infected animals may predispose them to infection^{2,7}. The primary route of transmission is aerosol, with the lungs being the principal site of infection; however, hematogenous and lymphatic dissemination may occur in advanced stages leading to multisystemic involvement^{1,4}. Physiological stressors such as pregnancy and compromised immunity may further exacerbate disease progression and severity^{6,8}.

Gross pathological findings in tuberculosis are typically characterized by multiple nodular lesions (tubercles) in the lungs and associated lymph nodes, which may show caseation and calcification in chronic stages of infection^{5,9}. In disseminated forms, lesions may extend to extrapulmonary organs including liver, spleen and occasionally the heart, indicating systemic spread^{3,6}. Cardiac involvement, although rare, has been documented and may manifest as myocarditis due to inflammatory infiltration and myocardial degeneration^{4,10}.

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Histopathologically, tuberculosis is characterized by the formation of granulomas consisting of a central area of caseous necrosis surrounded by epithelioid macrophages, Langhans-type multinucleated giant cells, lymphocytes and fibrous connective tissue encapsulation^{1,5}. These granulomatous lesions represent a host immune response aimed at containing the infection but may also contribute to progressive tissue destruction and organ dysfunction. Histopathological examination thus remains the gold standard for definitive diagnosis, particularly in wildlife species where antemortem diagnostic approaches are limited^{2,7}.

The epidemiology of tuberculosis in wildlife is influenced by multiple factors including environmental conditions, population density, management practices and interaction with domestic animals or humans^{3,8}. Despite its recognized importance, reports of tuberculosis in giraffes remain scarce, especially in the Indian context, with limited studies documenting detailed pathological and systemic involvement.

The present study was therefore undertaken to investigate the gross and histopathological alterations associated with tuberculosis in a pregnant giraffe, with special emphasis on pulmonary granulomatous lesions and cardiac involvement. The findings are expected to contribute to a better understanding of the pathological manifestations and systemic impact of tuberculosis in exotic wildlife species, thereby aiding in improved diagnosis and disease management strategies.

MATERIALS & METHODS

The present study was conducted on a deceased 16-year-old female giraffe (*Giraffa camelopardalis*), approximately 13 months pregnant, maintained under captive conditions at Sanjay Gandhi Biological Park, Patna. The animal died following a history of progressive anorexia, lethargy, weight loss, and general debility. Detailed anamnesis regarding clinical signs, duration of illness and management conditions was recorded from the caretakers prior to necropsy. During

postmortem examination, the animal was in lateral recumbency showing an intact external body with apparent abdominal distension (Fig. 1).

A systematic and thorough postmortem examination was performed following standard necropsy procedures¹¹. External examination included assessment of body condition, mucous membranes and any visible lesions. Internal examination revealed gross pathological alterations in various organs, with particular emphasis on the respiratory and cardiovascular systems. The lungs were carefully examined for size, consistency, colour and presence of nodular lesions while the heart was evaluated for any changes in size, shape and myocardial appearance. Representative tissue samples from lungs and heart were collected for further laboratory investigation.

For histopathological examination, tissue samples were immediately fixed in 10% neutral buffered formalin for 24–48 hours. Fixed tissues were processed using standard paraffin embedding techniques. Sections of 4–5 µm

thickness were prepared using a microtome and stained with Haematoxylin and Eosin (H&E) for microscopic evaluation¹². The stained sections were examined under a light microscope to identify characteristic pathological changes, particularly granulomatous lesions in the lungs and inflammatory changes in cardiac tissue.

Based on gross and histopathological findings, a presumptive diagnosis of tuberculosis was made; however, in the absence of Ziehl–Neelsen staining or molecular confirmation, the diagnosis remains morphological. All procedures were conducted in accordance with standard ethical guidelines for postmortem examination.

RESULTS & DISCUSSIONS

Gross postmortem examination of the giraffe revealed severe pathological alterations predominantly in the respiratory system. The lungs were markedly enlarged, heavy and firm in consistency, and extensively studded with numerous, variably sized grayish-white nodules distributed throughout all lobes. On cut section of both lungs, these nodules exhibited caseous and gritty material, indicative of chronic granulomatous inflammation (Fig. 2 & Fig. 3). In some areas, coalescing lesions formed larger consolidated patches suggestive of advanced disease. Similar gross findings of multiple caseating tubercles in the lungs have been widely reported in tuberculosis of domestic and wild animals^{5,9}.

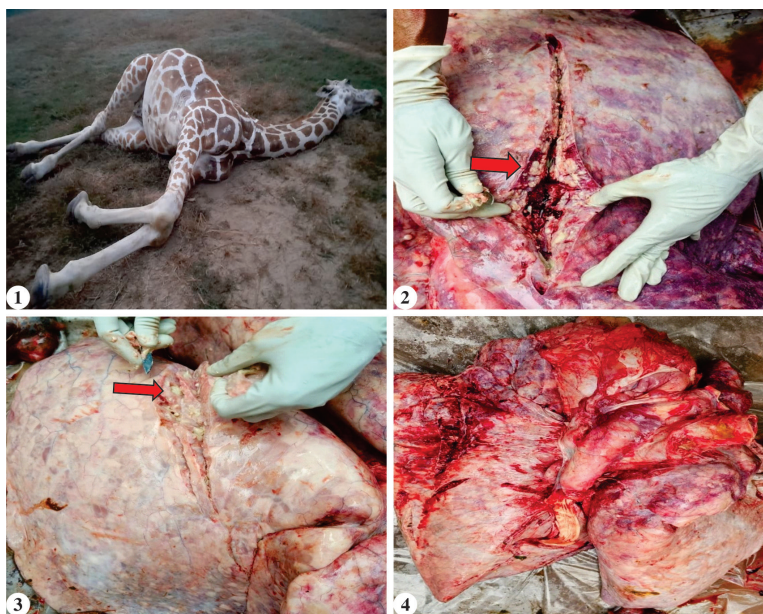


Fig.1. Gross photograph of a giraffe in lateral recumbency during postmortem examination showing an intact external body with apparent abdominal distension; **Fig.2.** Cut surface of the right lung showing numerous coalescing grayish-white nodules with central caseous necrosis; **Fig.3.** Cut surface of the left lung showing multiple disseminated grayish-white nodular lesions with caseous material; **Fig.4.** Gross view of lungs with heart showing congestion, multiple nodular lesions and cardiac enlargement

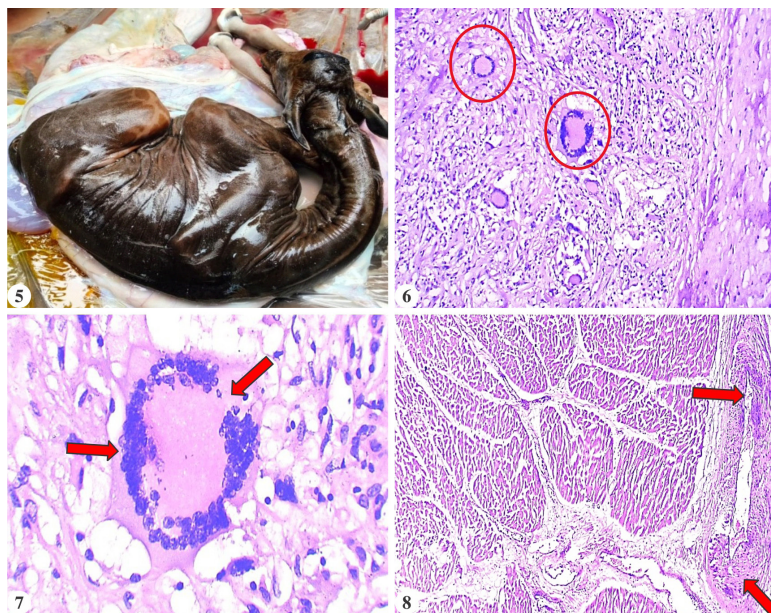


Fig.5. Gross photograph of a near-term giraffe foetus recovered during post-mortem examination, showing a well-developed foetus with intact foetal membranes following intrauterine death; **Fig.6.** Histological section of lung of giraffe showing granulomatous inflammation with central caseous necrosis surrounded by epithelioid cells and Langhans giant cells (H&E, 100x); **Fig.7.** Histological section of lung of giraffe showing a higher magnification view of granulomatous lesion with prominent central caseous necrosis and a surrounding rim of epithelioid macrophages and Langhans giant cells (H&E, 400x); **Fig.8.** Histological section of heart of giraffe showing myocardial fibre degeneration with interstitial edema and mononuclear inflammatory cell infiltration (H&E, 100x).

The tracheobronchial lymph nodes were also enlarged and exhibited caseation, supporting systemic dissemination.

The heart appeared mildly enlarged with congestion (Fig. 4). These alterations were indicative of underlying degenerative and inflammatory processes. Although cardiac involvement in tuberculosis is relatively uncommon, comparable myocardial lesions associated with disseminated tuberculosis have been reported previously^{3,4}. No significant gross lesions were observed in other visceral organs, apart from mild congestion. Additionally, a near-term, well-developed foetus enclosed within intact foetal membranes was recovered from the uterus, suggestive of intrauterine death (Fig. 5).

Histopathological examination of lung sections (H&E, 100x and 400x) revealed classical granulomatous lesions characterized by central caseous necrosis surrounded by epithelioid macrophages, numerous Langhans-type multinucleated giant cells and a peripheral rim of lymphocytes and fibrous connective tissue encapsulation (Fig. 6 & 7). Adjacent pulmonary parenchyma showed congestion, edema and infiltration of inflammatory cells. These findings are consistent with the typical histomorphological features of tuberculosis as described in earlier studies^{1,10}.

Microscopic examination of cardiac tissue (H&E, 100x) revealed myocardial fibre degeneration, interstitial edema and

infiltration of mononuclear inflammatory cells, confirming myocarditis (Fig. 8). The presence of inflammatory infiltration in the myocardium suggests possible hematogenous spread of infection, which has been reported in advanced or disseminated tuberculosis^{2,7}.

The observed lesions clearly indicate a disseminated form of tuberculosis with primary pulmonary involvement and secondary cardiac changes. The chronic granulomatous inflammation observed in the lungs reflects a well-established host immune response attempting to contain the infection; however, progressive caseation and tissue destruction ultimately compromise organ function^{1,6}. The presence of myocarditis further suggests systemic spread and increased disease severity.

The occurrence of tuberculosis in an advanced pregnant giraffe highlights the possible role of physiological stress and immunomodulation during pregnancy, which may predispose to disease progression and dissemination. Similar observations have been made in other species where immunosuppression contributes to reactivation or exacerbation of latent infections⁸.

The findings of the present study are in accordance with previous reports describing tuberculosis as a chronic, multisystemic disease with predominant pulmonary lesions and occasional extrapulmonary involvement in wildlife species^{3,9}. The absence of antemortem diagnosis and the reliance on postmortem and histopathology emphasize the challenges associated with early detection in exotic animals.

Overall, the study underscores the importance of detailed necropsy and histopathological evaluation in identifying lesions suggestive of tuberculosis in wild and captive animals. However, in the absence of Ziehl–Neelsen staining or molecular confirmation, the diagnosis remains presumptive, as other granulomatous diseases may produce similar lesions. The findings highlight potential systemic involvement, including cardiac lesions and emphasize the need for confirmatory diagnostics, improved surveillance, management and biosecurity in captive wildlife populations.

CONCLUSION

Tuberculosis in giraffe is a significant

infectious disease, particularly under stress conditions such as captivity and advanced pregnancy, due to its chronic, progressive and multisystemic nature. The present study highlights pulmonary granulomatous lesions with concurrent myocardial involvement, indicating systemic dissemination. As antemortem signs are often nonspecific, accurate diagnosis relies on postmortem and histopathological evaluation, underscoring the need for routine monitoring and strict biosecurity in captive populations

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