Review

The role of the dental practitioner in diagnosing oral tuberculosis

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Abstract: Tuberculosis remains a major global cause of morbidity and mortality, disproportionately affecting vulnerable populations, including children and individuals with HIV infection. Early and accurate diagnosis is critical for effective treatment and for interrupting transmission. Traditional diagnostic methodologies, often relying on sputum examination, face significant limitations in specific clinical contexts. Researchers are actively exploring innovative diagnostic approaches, focusing intensely on non-sputum-based biological samples and the identification of specific biomarkers. Although oral manifestations of tuberculosis are less common, they can provide essential clues for early disease detection. In this narrative mini-review, we summarized the evolving methods of diagnosing tuberculosis, emphasizing the pivotal role of dental professionals in identifying oral manifestations and the importance of precise laboratory diagnostics. The review provides an updated overview of diagnostic challenges and advancements, including the potential of non-sputum samples and novel biomarkers, while discussing relevant comorbidities such as silicosis.

1. Introduction

Tuberculosis remains a leading global cause of morbidity and mortality, disproportionately affecting vulnerable populations, including individuals with HIV infection and children [1–3]. Tuberculosis is transitate mainly via aerosols and is engulfed by alveolar macrophages in the lungs of the infected hosts. Early and accurate diagnosis of tuberculosis is crucial for effective treatment and to interrupt transmission. However, traditional diagnostic methodologies, often relying on sputum examination, face significant limitations, particularly in specific clinical contexts [2,3]. Researchers have actively focused on the development of innovative diagnostic approaches. Among these, the exploration of non-sputum-based biological samples and the identification of specific biomarkers represent areas of intense interest [2–4]. Concurrently, understanding the interplay between tuberculosis and other conditions, such as silicosis, is proving fundamental for optimal clinical management [5,6]. Furthermore, although oral manifestations of tuberculosis are less common and may occur following pulmonary tuberculosis, they can provide clues for early disease detection [6,7]. In this paper, we aim to provide an updated overview of the advancements and challenges in tuberculosis diagnosis, exploring the potential of non-sputum-based samples and novel biomarkers. Relevant aspects concerning comorbidities, such as silicosis and oral manifestations of TB, are also discussed to provide a comprehensive perspective on strategies to improve the diagnosis and management of this complex disease.

2. Materials and methods

This review was conducted following a systematic approach to synthesize current knowledge on the diagnosis of tuberculosis, focusing on non-sputum-based samples and the role of dental professionals in identifying oral manifestations.

2.1. Search strategy and data sources

A comprehensive search of relevant literature was performed using electronic databases, including PubMed/MEDLINE, Scopus, Web of Science, and Google Scholar. The search strategy employed a combination of keywords and MeSH terms related to tuberculosis, diagnosis, laboratory techniques, biomarkers, non-sputum samples (e.g., urine, stool, saliva), oral manifestations, and the role of dentists. The search terms were adapted for each database to maximize the retrieval of relevant articles. The search was limited to articles published in English. Additionally, the references of identified articles and relevant reviews were manually screened to identify any further pertinent studies. The search period spanned January 1980 to December 2024 to capture the most recent advancements in the field.

2.2. Inclusion and exclusion criteria

Studies were included in this review if they met the following criteria: (1) Focused on the diagnosis of *Mycobacterium tuberculosis* infection; (2) investigated the use of non-sputum-based samples for tuberculosis diagnosis; (3) addressed oral manifestations of tuberculosis; or (4) discussed the role of dental professionals in the diagnosis or management of oral tuberculosis. Studies were

excluded if they were: (1) Not focused on human subjects; (2) case reports or case series (unless providing unique insights into oral manifestations); (3) focused solely on treatment or prevention of tuberculosis without significant discussion of diagnostic aspects; (4) not available in English; or (5) were opinion pieces, editorials, or conference abstracts without sufficient original data.

2.3. Data extraction and synthesis

Data from the included studies were extracted using a standardized data extraction form. This form included information on the study design, study population, sample type, diagnostic methods used, biomarkers investigated (if applicable), the prevalence of oral manifestations (if reported), and the reported role of dental professionals. Data extraction was performed by two independent reviewers to minimize bias, and any discrepancies were resolved through discussion and consensus. The synthesized information was organized to provide an overview of the current landscape of tuberculosis diagnostics, highlighting the challenges and advancements in non-sputum-based approaches and biomarker research. Special attention was given to studies reporting on oral manifestations of TB and the diagnostic pathways involving dental professionals.

2.4. Data analysis

Given the heterogeneity of study designs and outcomes, a narrative synthesis of the data was primarily conducted. Where possible and appropriate, descriptive statistics (e.g., frequencies, percentages) from relevant studies were extracted and summarized to provide quantitative context, particularly regarding the prevalence of oral manifestations or the performance of specific diagnostic tests. Meta-analysis was planned if sufficient homogeneous data on specific diagnostic outcomes were available; however, based on the initial search and screening, a narrative synthesis was deemed more appropriate to address the broad scope of this review.

3. Discussion

The accurate and timely laboratory diagnosis of tuberculosis holds significant clinical implications, extending into the realm of dental practice [8]. While pulmonary involvement remains the primary manifestation of tuberculosis, the potential for extrapulmonary spread, including the oral cavity, necessitates a heightened awareness among dental professionals. Oral lesions, though reported as uncommon, can be the initial or sole presentation of tuberculosis, particularly in immunocompromised individuals such as those with HIV infection [9–11]. Therefore, the capacity to recognize and appropriately investigate suspicious oral lesions through robust laboratory methods is crucial for patient management and public health. Traditional sputum-based diagnostic approaches for tuberculosis face inherent limitations when considering oral manifestations. Patients with isolated oral tuberculosis may be asymptomatic from a pulmonary perspective or unable to expect adequate sputum for analysis [12,13]. In these scenarios, tissue biopsy of the oral lesion becomes the cornerstone of diagnosis. Histopathological examination of the biopsied tissue can reveal characteristic granulomatous inflammation with Langerhans giant cells, raising suspicion for tuberculosis (Figure 1).
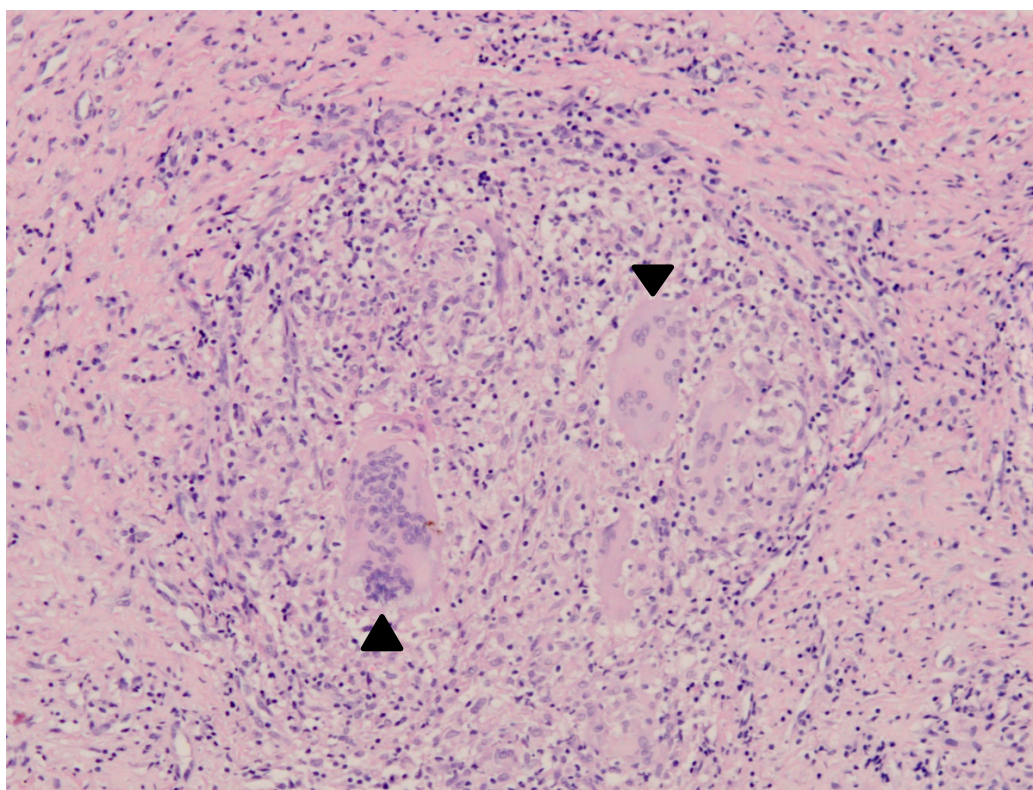
Figure 1. Primary granuloma with multinucleated giant cell reaction (arrowhead).

However, definitive confirmation requires microbiological analysis. Acid-fast stainings, such as the Ziehl-Neelsen stain, performed on tissue smears or sections can provide a rapid preliminary indication of the presence of *M. tuberculosis* (Figure 2) [1,3–5,14]. Nevertheless, the sensitivity of direct staining can be limited, and the absence of acid-fast bacilli does not rule out tuberculosis. Mycobacterial culture of the biopsy specimen remains the gold standard, offering the highest sensitivity and enabling species identification and drug susceptibility testing, which are critical for guiding treatment regimens [15,16]. The evolving landscape of tuberculosis diagnostics, with increasing emphasis on non-sputum-based samples and biomarker identification [17,18], holds promise for improving the diagnosis of oral tuberculosis. While researchers focusing on the utility of oral fluids (e.g., saliva and oral swabs) for tuberculosis diagnosis is emerging, the potential for less invasive sampling methods in the dental setting is evident. These approaches could be particularly beneficial in cases where biopsies are challenging to obtain or in pediatric patients where sputum collection is often difficult. The identification and validation of specific salivary or oral mucosal biomarkers indicative of local or systemic tuberculosis infection could revolutionize diagnostic workflows in dentistry, enabling earlier detection and intervention [19–21]. The clinical significance of laboratory-confirmed oral tuberculosis extends beyond individual patient care. The identification of an active tuberculosis case, regardless of the site of manifestation, carries public health implications due to the potential for transmission. Dental professionals play a vital role in recognizing suspicious lesions and facilitating appropriate laboratory investigations, thereby contributing to the early detection of infectious individuals and enabling the timely implementation of infection control measures to prevent further spread within the community. This is particularly important in high-burden settings and among vulnerable populations [22,23]. Furthermore, the interplay between tuberculosis

and other systemic conditions frequently encountered in dental practice underscores the importance of a comprehensive diagnostic approach. For instance, individuals with HIV infection exhibit a higher susceptibility to tuberculosis and may have atypical or more aggressive oral manifestations. Similarly, the documented association between silicosis and an increased risk of tuberculosis [24,25] highlights the need for vigilance in patients with relevant occupational histories. Dental professionals should be aware of these associations and consider tuberculosis in the differential diagnosis of oral lesions in at-risk individuals, prompting appropriate laboratory investigations. Effective communication and collaboration between dentists, physicians, and laboratory specialists are crucial to ensure accurate diagnosis and coordinated patient management.
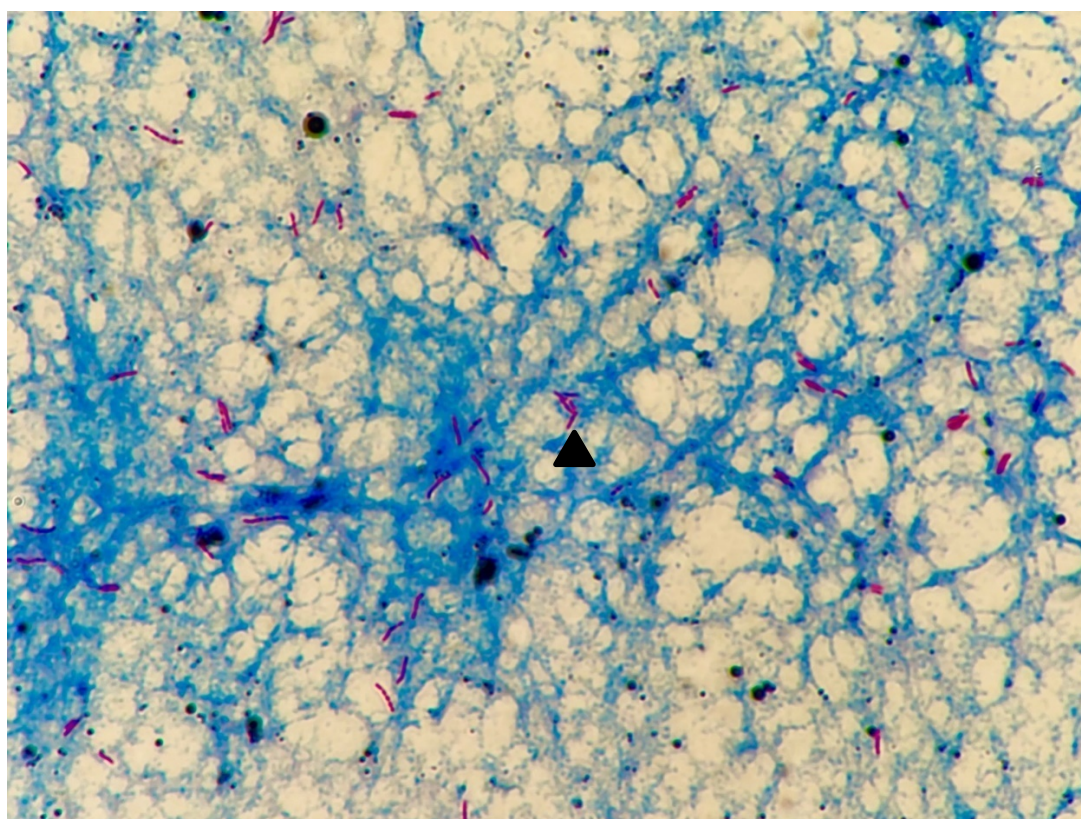

Figure 2. BAAR in positive smear sputum (arrowhead).

4. Conclusions

Effective tuberculosis management, encompassing its subtle oral signs, critically depends on a seamless collaboration between sharp clinical detection by dental experts and rigorous laboratory diagnostics. While TB primarily affects the lungs, it is vital to remember that extrapulmonary forms, particularly in the mouth, demand constant vigilance, especially among at-risk groups. Research suggests that oral tuberculosis lesions, though sometimes overlooked, might appear in up to 1–5% of all TB cases, a figure that could climb significantly higher in immunocompromised individuals like those with HIV co-infection. Tripathi et al. (2011) [26] highlight that in individuals with HIV/AIDS, the likelihood of atypical and extrapulmonary presentations of tuberculosis, including oral lesions, is increased, although precise percentage data for oral involvement in this cohort requires further

consolidated research. Chan et al.'s (2013) [27,28] review underscores the diverse clinical presentations of oral tuberculosis, which can mimic other common oral pathologies, emphasizing the limitations of relying solely on clinical assessment. The laboratory's role is indispensable for definitively diagnosing oral tuberculosis. Annually, a microbiology laboratory within a hospital HUB—Central Hospital, like ours, handles more than a thousand samples (originating from diverse anatomical sites) for the identification of Koch's bacillus. Microbiological confirmation is indispensable to diagnose oral tuberculosis, even though histopathological analysis of oral tissue often provides strong clues. For instance, the detection of granulomatous inflammation during biopsy examination can be highly suggestive. Complementing this, acid-fast staining methods can offer a quicker preliminary indication, with studies showing they may identify between 50% and 80% of culture-verified cases, depending on the bacterial concentration. It is worth noting that specific diagnostic sensitivities for oral lesions might differ from overall data [29]. Despite the utility of quicker methods, mycobacterial culture remains the definitive "*gold standard*" for tuberculosis diagnosis. It boasts an impressive sensitivity, typically ranging from 80% to 95% in pulmonary cases, and offers vital insights into the specific *M. tuberculosis complex* involved and, crucially, its drug susceptibility profile. This latter point is especially critical in light of rising global concerns about multidrug-resistant tuberculosis (MDR-TB), where precise susceptibility testing is absolutely essential for tailoring effective treatment regimens [29]. The evolving field of tuberculosis diagnostics offers promising avenues for improving the detection of oral tuberculosis. While specific sensitivity and specificity data for oral fluid-based tuberculosis tests in the context of oral lesions are under investigation, the potential for a less invasive diagnostic approach is significant, particularly in pediatric or non-expectorating patients. The identification of specific biomarkers in oral fluids could further enhance diagnostic accuracy and potentially enable point-of-care testing in dental settings. Dental professionals play an indispensable role at the forefront of identifying potential oral tuberculosis early. Their ability to recognize suspicious lesions and swiftly refer patients to the necessary laboratory workup constitutes a vital first step. Clinical suspicion should be sharpened by an increased awareness of key risk factors, including HIV co-infection (where the prevalence of oral tuberculosis could range from 2% to 10%, according to some case series and prevalence data of oral manifestations in HIV-positive individuals), a history of silicosis, or residence in areas where tuberculosis is widespread. Consequently, the dentist's prompt submission of biopsy samples for histopathology and mycobacterial culture becomes a pivotal point in the diagnostic journey. This not only facilitates an accurate diagnosis and the timely start of anti-tuberculous treatment for the individual patient but also contributes significantly to wider public health initiatives aimed at curbing tuberculosis transmission [30,31].

Use of AI tools declaration

The authors declare they have used Artificial Intelligence (AI) tools for English improvement and the reorganization of some concepts in the creation of this article.

Conflict of interest

The authors declare no conflict of interest.

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