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ULTRASOUND IMAGING IN MYCETOMA AND CORRELATION WITH MRI & CT

Radio-Diagnosis

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ABSTRACT

Background: Mycetoma is a chronic granulomatous infection predominantly affecting the skin, subcutaneous tissues, and bones, most commonly seen in tropical and subtropical regions. It is associated with significant morbidity due to delayed diagnosis and management. Non-invasive imaging plays an important role in early detection, differentiation between actinomycetoma and eumycetoma, and planning treatment strategies. **Objective:** The objective of this study was to assess the sonographic features of foot mycetoma, with a particular focus on the "dot-in-circle" sign, and to correlate these findings with magnetic resonance imaging (MRI) and computed tomography (CT) to evaluate the extent of disease involvement. **Materials and Methods:** A prospective observational study was conducted on ten patients clinically suspected to have foot mycetoma. All patients underwent ultrasound imaging, MRI, and CT scans. Imaging findings were recorded systematically and correlated with histopathological and microbiological confirmation wherever available. **Results:** The "dot-in-circle" sign was detected in all patients on both ultrasound and MRI. CT imaging was particularly effective in identifying cortical bone erosions and periosteal reactions, with bone involvement detected in nine out of ten cases. Actinomycetoma was found to be more common than eumycetoma in the studied population. **Conclusion:** Ultrasonography, complemented by MRI and CT, provides a non-invasive, reliable, and efficient method for the early diagnosis and staging of mycetoma. Recognition of characteristic imaging features can facilitate prompt management, potentially preventing severe complications and disability in affected individuals.

KEYWORDS

INTRODUCTION:

Mycetoma is a chronic, granulomatous infection of the skin and subcutaneous tissues that predominantly affects individuals living in tropical and subtropical regions. It is caused either by filamentous bacteria (actinomycetoma) or by true fungi (eumycetoma), and its clinical presentation remains remarkably similar regardless of the etiological agent involved [1]. The disease typically arises following minor trauma or puncture wounds, allowing direct inoculation of the causative organisms from soil or plant material. It most commonly affects the foot but can involve other exposed areas of the body such as the hands, back, or knees [2].

Clinically, mycetoma is characterized by a triad of painless soft tissue swelling, multiple discharging sinuses, and extrusion of grains. However, the progression is slow and often painless in the early stages, which contributes to delayed medical consultation and diagnosis. Over time, untreated cases can result in extensive soft tissue destruction, osteomyelitis, deformities, and, eventually, the need for amputation [3]. Early detection is crucial, as it can dramatically alter the course of the disease, prevent permanent disability, and reduce the psychological and socioeconomic burden on affected individuals [4].

Definitive diagnosis traditionally relies on microbiological culture, histopathology, and cytology to identify the causative organisms. However, these methods are time-consuming, invasive, and not always reliable, particularly in resource-limited settings where laboratory facilities are scarce [5]. Therefore, non-invasive imaging modalities have become essential tools for the early detection and characterization of mycetoma.

Among imaging techniques, ultrasonography (USG) has proven highly valuable due to its low cost, widespread availability, and the ability to provide immediate results. The identification of the "dot-in-circle" sign on USG is considered a pathognomonic finding for mycetoma, representing hyperreflective grains ("dot") within a hypoechoic inflammatory granuloma ("circle") [6]. Magnetic resonance imaging (MRI) also demonstrates the "dot-in-circle" sign on T2-weighted and STIR sequences and offers superior soft tissue contrast to evaluate the extent of disease spread into muscles, tendons, and joints [7].

Computed tomography (CT), while not as sensitive for early soft tissue involvement, is indispensable for detecting cortical bone destruction, periosteal reaction, and sequestrum formation, which are vital in determining prognosis and guiding surgical interventions [8]. The combination of USG, MRI, and CT thus provides a comprehensive approach to diagnosis, staging, and management planning.

Despite these advancements, mycetoma remains a neglected disease with significant diagnostic challenges, particularly in endemic regions where clinical suspicion must be supplemented by appropriate imaging. Recognizing this need, the present study was undertaken to evaluate the role of ultrasonography in diagnosing foot mycetoma, emphasizing the "dot-in-circle" sign, and to correlate these findings with MRI and CT results. This approach aims to facilitate earlier diagnosis, appropriate therapeutic interventions, and ultimately better clinical outcomes for affected patients.

METHODOLOGY:

This prospective observational study was conducted at the Department of Radiodiagnosis, Government Medical College and Hospital, Aurangabad, over a period of one year from January 2024 to December 2024. A total of ten patients clinically suspected to have foot mycetoma, based on typical features such as chronic swelling, multiple discharging sinuses, and a history of minor trauma, were enrolled. Institutional ethics committee approval was obtained, and informed consent was taken from all participants.

Patients who had undergone previous surgical interventions on the foot, known cases of malignancy, or those with incomplete imaging records were excluded from the study. Demographic data, clinical history, and imaging findings were systematically recorded.

All patients underwent ultrasound examination using a Samsung HS50 machine equipped with high-frequency linear transducers (7–12 MHz). Gray scale and color Doppler imaging were utilized to assess lesion characteristics, vascularity, and to specifically look for the "dot-in-circle" sign. MRI studies were performed on a GE 3 Tesla system, including T1-weighted, T2-weighted, STIR, proton density, and post-contrast fat-suppressed sequences, to evaluate soft tissue and bone marrow involvement. CT scans were done using a Siemens 128-slice system to assess cortical erosion, periosteal reaction, and other osseous changes.

The final diagnosis was confirmed by histopathological examination and/or microbiological culture of tissue or discharge samples. Data were analyzed descriptively, and findings were compared across the three imaging modalities.

RESULT:

The present study included ten patients clinically suspected to have foot mycetoma, referred to the Department of Radiodiagnosis. The age of the patients ranged from 25 to 65 years, with a mean age of 42.5 years. The majority of patients were male, comprising 80% (8/10) of the cohort, while females accounted for 20% (2/10). In terms of laterality, the right foot was involved in six cases (60%), and the left foot in four cases (40%).

On ultrasonography, all patients demonstrated the characteristic "dot-in-circle" sign. This was seen as well-defined hypoechoic nodules containing central echogenic foci, correlating with the grains surrounded by inflammatory granulation tissue. In addition to gray-scale findings, color Doppler imaging revealed peripheral vascularity around the lesions in all cases, suggestive of an active inflammatory process.

MRI findings corroborated the ultrasound findings, with all patients showing multiple hyperintense lesions on T2-weighted and STIR sequences, each containing central hypointense foci corresponding to the grains. These features created the classic "dot-in-circle" appearance on MRI as well. On post-contrast images, peripheral rim enhancement was noted around the lesions, further supporting the diagnosis of mycetoma. MRI was also helpful in assessing the extent of soft tissue involvement and in detecting early marrow changes in a few cases.

Computed tomography was primarily utilized to evaluate bone involvement. Bone erosions, cortical breaches, and periosteal reactions were observed in nine out of ten patients (90%). CT imaging was superior to USG and MRI in detecting fine bony details, particularly subtle cortical destructions and sequestrum formation.

Based on histopathological and microbiological confirmation, actinomycetoma was diagnosed in seven patients (70%), whereas three patients (30%) had eumycetoma. Notably, bone involvement was more extensive among patients with actinomycetoma as compared to those with eumycetoma.

The summarized findings across imaging modalities are presented in the table below:

Table 1: Comparison of key imaging features of foot mycetoma across ultrasonography (USG), magnetic resonance imaging (MRI), and computed tomography (CT) in ten patients.

Imaging Characteristic	USG (n=10)	MRI (n=10)	CT (n=10)
"Dot-in-circle" sign	10	10	0
Soft tissue swelling	10	10	10
Bone involvement detected	4	5	9
Color Doppler vascularity	10	N/A	N/A

Figure 1. Gray-scale ultrasonography of the foot shows multiple well-defined, conglomerate hypoechoic lesions with central hyperechoic foci (white arrows), consistent with the characteristic "dot-in-circle" sign. Schematic diagram illustrates the pathological correlation: central fungal ball or grains surrounded by inflammatory granuloma and fibrous matrix.

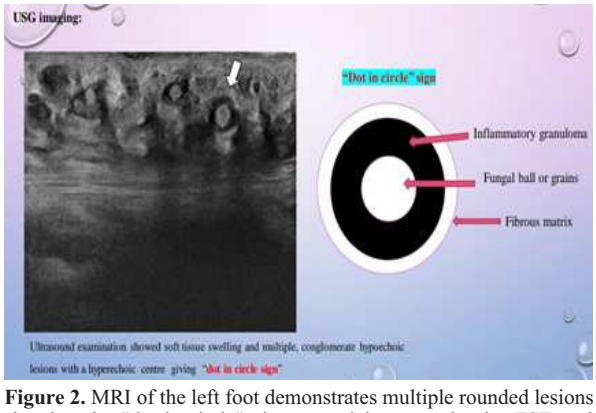
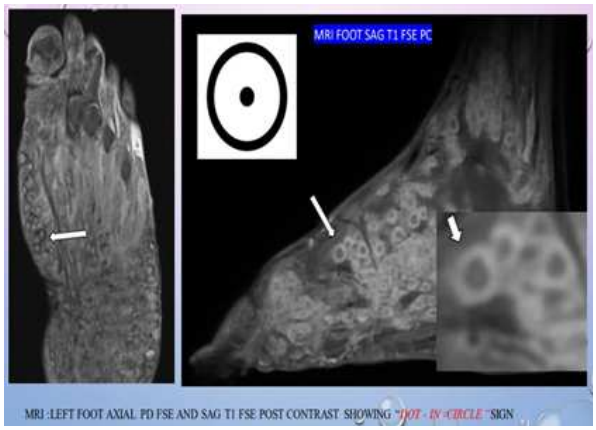


Figure 2. MRI of the left foot demonstrates multiple rounded lesions showing the "dot-in-circle" sign on axial proton density FSE and sagittal post-contrast T1 FSE images. The lesions appear as hyperintense nodules with central hypointense dots (white arrows), corresponding to grains within granulomas.



Overall, ultrasonography effectively identified the hallmark features of mycetoma in all cases, MRI contributed significantly in defining the extent of soft tissue involvement, and CT proved indispensable in evaluating osseous changes.

DISCUSSION:

Mycetoma continues to be a significant health burden in tropical and subtropical regions, largely due to its chronic course, delayed diagnosis, and associated morbidity. Imaging plays an essential role in the early detection and characterization of this disease, helping to prevent complications such as bone destruction, deformity, and disability. In this study, we evaluated the sonographic appearance of mycetoma, specifically focusing on the "dot-in-circle" sign, and correlated these findings with MRI and CT imaging.

Ultrasonography (USG) proved to be a highly sensitive and cost-effective modality for the initial assessment of mycetoma. In our study, the "dot-in-circle" sign was consistently observed in all patients, aligning with previous findings reported in the literature. This sign represents the basic pathological process where hyperintense fungal or bacterial grains ("dot") are surrounded by hypointense inflammatory granulomas ("circle") [5,6]. The easy detection of this hallmark feature on USG, particularly in endemic regions with limited resources, emphasizes the utility of ultrasound as a frontline diagnostic tool. Additionally, color Doppler evaluation revealed increased vascularity around the lesions, further supporting the diagnosis and ruling out avascular cystic lesions or necrotic tumors.

MRI provided further detailed anatomical assessment, particularly in evaluating the extent of soft tissue involvement, intermuscular extension, and early bone marrow changes. T2-weighted and STIR sequences highlighted multiple hyperintense lesions with central hypointense foci, consistent with the "dot-in-circle" configuration observed on ultrasound. Post-contrast sequences demonstrated peripheral rim enhancement around lesions, reflective of active inflammation. These findings are consistent with previous studies by Laohawiriyakamol et al. and Yadav et al., who emphasized MRI's superiority in delineating disease spread and guiding surgical planning [5,7].

Although CT has limited sensitivity in soft tissue evaluation compared to MRI, it plays an indispensable role in identifying osseous involvement. In our series, CT scans detected bone erosion, cortical breaches, and periosteal reactions in nine out of ten cases. These bony changes often go undetected in early-stage mycetoma but are crucial in determining the prognosis and the need for surgical debridement or amputation. The importance of CT in evaluating bone involvement has also been emphasized in studies by Bentaleb et al. and Mhaili et al. [1,8]. In actinomycetoma cases, bone destruction was generally more severe and diffuse compared to eumycetoma, reflecting the aggressive nature of bacterial infections, a finding consistent with prior research [7].

The comparison of imaging findings across modalities in this study underscores the complementary roles of USG, MRI, and CT in the comprehensive assessment of mycetoma. Ultrasound remains invaluable for early, rapid diagnosis; MRI adds critical information about soft tissue and marrow involvement; and CT confirms the extent of bone damage.

Our findings reaffirm the significance of non-invasive imaging in the

early and accurate diagnosis of mycetoma, reducing dependency on invasive techniques such as biopsy, which can be delayed, expensive, or complicated by sampling errors. Recognizing characteristic imaging signs early can facilitate prompt initiation of appropriate antimicrobial or antifungal therapy, potentially avoiding extensive surgical interventions and improving long-term outcomes.

The strengths of our study include its prospective design, multimodal imaging correlation, and histopathological confirmation of diagnosis. However, certain limitations should be acknowledged. The small sample size and the single-center experience limit the generalizability of our findings. Larger, multicentric studies are needed to validate and expand upon these observations.

CONCLUSION:

Ultrasound imaging is an excellent initial investigation in suspected cases of mycetoma, especially in resource-limited settings. The 'dot-in-circle' sign, when correlated with MRI and CT findings, provides a comprehensive understanding of disease extent. Early imaging diagnosis can prevent complications, avoid unnecessary biopsies, and facilitate timely initiation of therapy, ultimately improving patient outcomes.

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