

Case Series of Three Cases of Madura's Foot with a Characteristic 'Dot in Circle' Sign: A Radiologist Perspective

SADAF SULTANA¹, MEHTAB AHMAD², SANA SULTANA³, MOHAMMAD ARIF⁴, INAM ULLAH KHAN⁵

ABSTRACT

Madura's foot is a rare infectious granulomatous disease affecting the foot. The incidence of this disease has decreased in recent years due to improved living conditions. However, it can still be misdiagnosed by inexperienced surgeons as other similar conditions. Early and accurate diagnosis is crucial for optimal treatment and limb preservation. In this study, the authors present three unusual cases of Madura's foot. A 23-year-old woman presented with swelling and draining sinuses in her left foot for six years. Imaging tests including Ultrasonography (USG), Computed Tomography (CT), and Magnetic Resonance Imaging (MRI) revealed the characteristic 'dot in circle' sign of Madura's foot. However, her USG-guided biopsy did not confirm the diagnosis, and it was only through an excisional biopsy that actinomycetoma was confirmed. Another case involved a 60-year-old male with multiple soft tissue swellings on his right foot for 10 years, resulting in foot deformity. Radiographs showed multiple punched-out lytic lesions in the bones, while USG and MRI exhibited the typical 'dot in a circle' sign. Histopathological examination confirmed actinomycetoma. The third case involved a 36-year-old male with a chronic sinus discharging yellow pus and black granules on the volar side of his right foot. USG and MRI revealed the classic signs of Madura's foot, and these findings were correlated with histopathological examination. The present cases confirm the specificity of the 'dot-in-circle' sign on MRI and USG, supported by histopathological correlation.

Keywords: Actinomycetoma, Granulomatous, Mycetoma, Ultrasonography

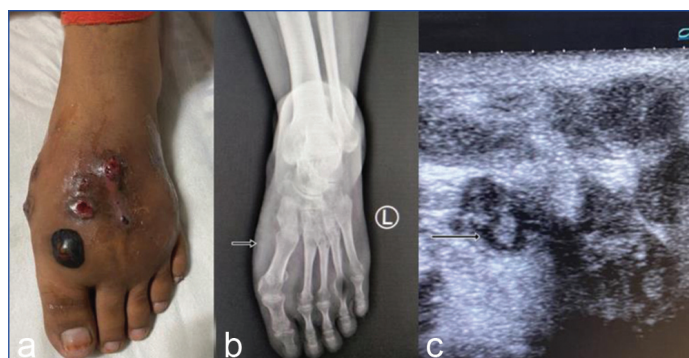
INTRODUCTION

Mycetoma is a chronic, slowly developing granulomatous infection that affects the skin and subcutaneous tissue. Its primary symptoms include swelling, discharge-producing sinuses, and granules in the discharge. The infection typically occurs through penetrating injuries or repeated minor trauma [1]. The foot and hand are the most commonly affected sites [2]. While microbiological culture and biopsy are reliable diagnostic methods, they can be time-consuming and may not provide a definitive diagnosis for organisms with complex nutritional requirements that are difficult to grow on standard culture media [3].

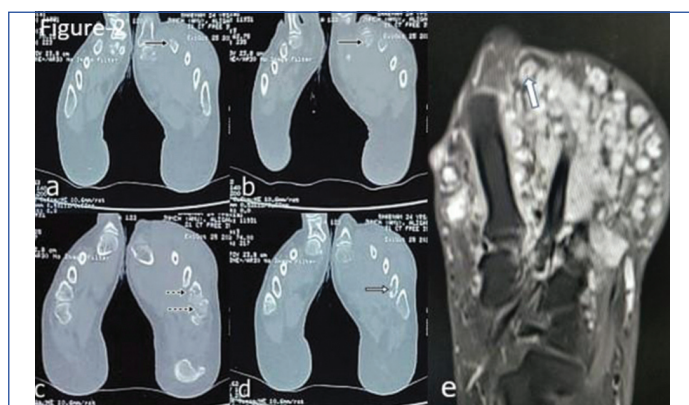
Case 1

A 23-year-old female patient presented to a tertiary care centre in Northern India with multiple swellings and draining sinuses on the dorsal aspects of her left foot, which had been present for six years [Table/Fig-1a]. On examination, the patient had no fever or palpable nodes in the regional areas. The dorsal aspect of the left foot showed black discoloration, several ill-defined swellings, and multiple non-tender sinuses with yellowish discharging grains. Culture and sensitivity testing of the purulent discharge revealed *Staphylococcus aureus* with no fungal growth. Conventional Radiograph (CR) of the left foot showed soft tissue prominence on the dorsal aspect [Table/Fig-1b]. Ultrasonography (USG) revealed the characteristic 'dot in circle' sign with surrounding inflamed fat [Table/Fig-1c]. Non-Contrast Computed Tomography (NCCT) depicted superficial erosions of multiple metatarsals [Table/Fig-2a-d]. Magnetic Resonance Imaging (MRI) of the left foot revealed multiple nodular lesions with a peripheral rim, creating a target-like "dot-in-circle" appearance [Table/Fig-2e].

The patient was treated with the Modified Welsh regimen, consisting of three cycles of intravenous Amikacin (500 mg) for 21 days each, followed by a four-week regimen of oral Trimethoprim (160 mg) - Sulfamethoxazole (800 mg) combination twice a day. Medical treatment resulted in complete recovery of all sinuses. The patient later underwent surgery [Table/Fig-3a-c] and continued the oral



[Table/Fig-1]: (a) Gross image showing several swellings and draining sinuses on the dorsal aspect of the foot; (b) X-ray (AP view) shows soft tissue prominence at the medial side of the left foot (black arrow) with normal bone shadow; (c) USG shows multiple hypoechoic lesions with hyperechoic centres (black arrow) with surrounding echogenic proliferated fat on the dorsum of the left foot.



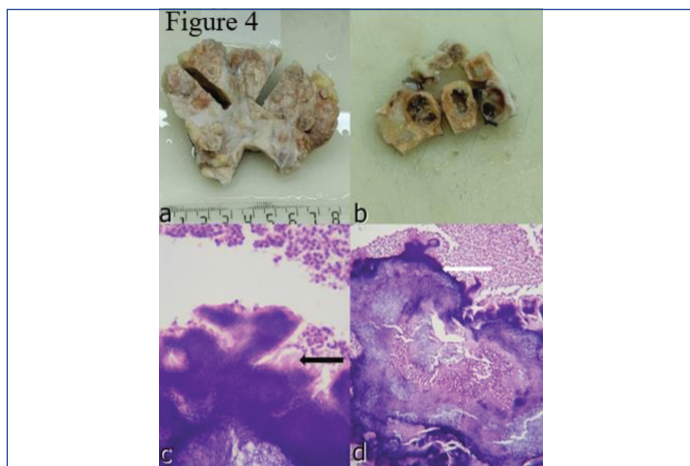
[Table/Fig-2]: (a, b) NCCT of the left foot (bone window) with early superficial erosion of the head of the second metatarsal (black arrows); (c) Erosion at the base of the third and fourth metatarsal bone (broken arrows); and (d) Erosion at the shaft of the 4th metatarsal (white arrow); (e) Postcontrast fat-saturated T1W MRI image shows multiple nodular lesions with the typical "dot in circle" sign (white arrow).

Trimethoprim 160 mg - Sulphamethoxazole 800 mg combination twice a day, along with Rifampicin 600 mg once a day for one month.

The excised specimen was sent for histopathological examination [Table/Fig-4a,b]. The histopathological findings showed dense suppurative granulomas surrounding the *Actinomyces* colony and radiating filamentous organisms, confirming actinomycetoma [Table/Fig-4c,d]. The patient remained symptom-free for six months after surgery [Table/Fig-3c] and has been regularly followed-up for the past two years without recurrence of symptoms. The patient expressed satisfaction with the treatment.



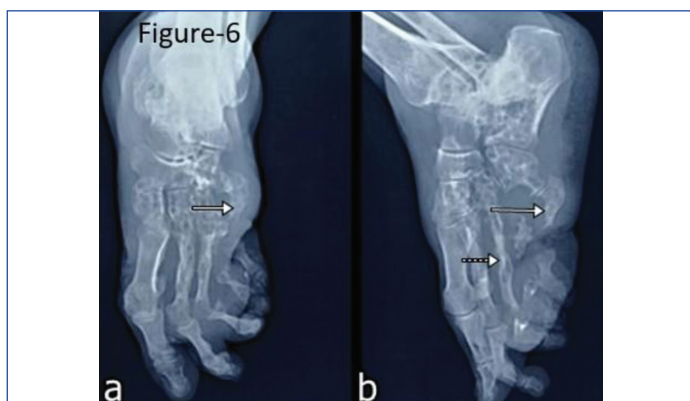
[Table/Fig-3]: (a) Incision made on the dorsum of the foot in the midline; (b) After the wound got covered with granulation tissue, split skin grafting was done; (c) Six-month follow-up depicted healed suture lines with no draining sinuses.



[Table/Fig-4]: (a) Gross specimen of the excised tissue; and (b) its cut section; (c) H&E stained slides showed radiating filamentous organisms (in the magnified view) (black arrow); and (d) dense suppurative granulomas surrounding the *Actinomyces* colony (white arrow).

Case 2

A 60-year-old male farmer presented to the plastic surgery department and radiology department of a tertiary care centre in Northern India with multiple soft tissue swellings on the dorsal aspect of his right foot, along with progressive deformity, for 10 years [Table/Fig-5a,b]. The patient initially experienced painless swelling, which gradually grew in size. Over the past two years, the swelling has caused difficulty in walking, wearing footwear, and continuing farming activities. The swelling eventually led to foot deformity.

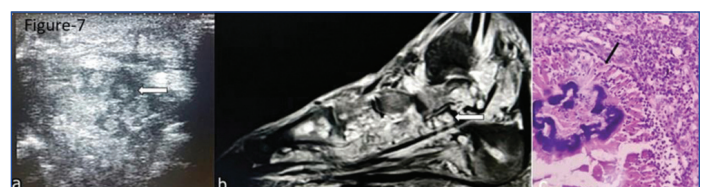


[Table/Fig-5]: (a) Multiple soft tissue swellings on the dorsal aspect of his right foot in lateral; and (b) front views.

On examination, the patient had no fever or lymphadenopathy. The dorsal aspect of the right foot showed discoloration, multiple swellings with ill-defined borders, and non-tender firmness without fluctuation. Several draining sinuses were also present. Conventional Radiograph (CR) of the right foot showed soft tissue prominence with multiple punched-out lytic lesions in the tarsal and metatarsal bones, along with toe deformity [Table/Fig-6a,b]. The post-operative follow-up clinical image of the patient is shown in [Table/Fig-6c]. Ultrasonography (USG) and Magnetic Resonance Imaging (MRI) showed the characteristic 'dot in circle' sign consistent with Madura's foot [Table/Fig-7a,b]. Microbiological investigations were inconclusive. The patient was treated with oral Itraconazole 200 mg twice a day for six months, resulting in a decrease in the number of discharging sinuses. Below-knee amputation was advised, and the patient underwent the procedure. Pus culture revealed *Staphylococcus aureus* growth. Excisional biopsy of the lesion was sent for histological analysis, which showed giant cells with sulfur granules. Histopathological examination revealed balls of eosinophilic radiating filaments surrounded by dense mixed inflammatory infiltrates [Table/Fig-7c]. PAS staining showed positively stained colonies, confirming the diagnosis of eumycetoma. After one year of follow-up, the patient remained free of previous symptoms [Table/Fig-6c]. The patient expressed satisfaction with the treatment received.



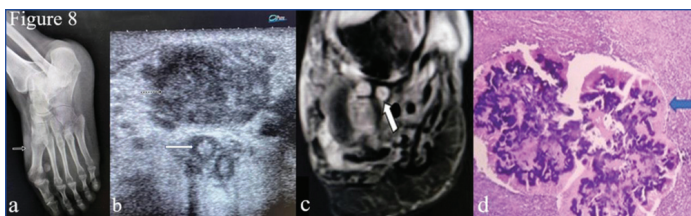
[Table/Fig-6]: (a) CR of the right foot was taken in anteroposterior; and (b) lateral views, which showed soft tissue prominence with multiple punched-out lytic lesions in the tarsal (white arrows) and metatarsal (broken arrows) along with lateral bent of the phalanges at the metatarsophalangeal joint. (c) Postoperative (below knee amputation) follow-up after one year of surgery.



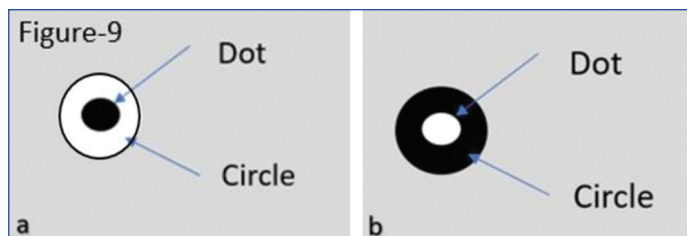
[Table/Fig-7]: (a) USG showed multiple round hypoechoic lesions with hyperechoic centres (marked by white arrow); (b) MRI (sagittal section T2 W) revealed multiple rounds to oval altered signal lesions in the subcutaneous and intermuscular planes, giving a "dot-in-circle" appearance (marked by white arrow); (c) HPE shows balls of eosinophilic radiating filaments (black arrow) surrounded by dense mixed inflammatory infiltrates.

Case 3

A 36-year-old male farmer presented to the dermatology department of a tertiary care centre in Northern India with a chronic sinus discharging yellow pus with black granules on the dorsal side of his right foot for six months, which started after a thorn prick on the foot. On examination, the patient had a normal temperature and no lymphadenopathy. Conventional Radiograph (CR) showed prominent soft tissue on the dorsal aspect of the foot [Table/Fig-8a]. Ultrasonography (USG) [Table/Fig-8b] and Magnetic Resonance Imaging (MRI) [Table/Fig-8c] depicted the classic 'dot in circle' sign of Madura's foot. Pus culture revealed no growth, but cytology and biopsy [Table/Fig-8d] confirmed Actinomycetoma. The patient received antibiotic therapy for actinomycetoma (same as the first patient) for six months, followed by surgery. After completing the treatment, the patient was symptom-free with no residual sinus. During a three-year follow-up, the patient did not develop any new symptoms and expressed full satisfaction with the treatment.



[Table/Fig-8]: (a) X-ray shows some soft tissue prominence at the dorsal aspect of the foot (black arrow); (b) US showed a few round hypoechoic lesions with hyperechoic centres (marked by white arrow) with hypoechoic granulation tissue (dotted arrow); (c) MRI (coronal section T2 WI) shows a few rounds to oval lesions in the intermuscular plane having a “dot-in-circle” sign (marked by white arrow) in STIR sequence; (d) HPE shows radiating eosinophilic filaments (blue arrow) surrounded by inflammatory cells.



[Table/Fig-9]: (a) Pictorial depiction of the “dot in circle” sign of MRI (T2-weighted image) (a). The dot represents the T2 hypointense (dark signal-shade of black) fungal or actinomycetes granule. The circle denotes the T2 hyperintense (bright signal-shade of white) abscess or granuloma with peripheral fibrous matrix; (b) On US, the hyperechoic (bright) centre is the colony of pathologic organism and the surrounding hypoechoic (dark) circle is the abscess or granulation tissue.

DISCUSSION

In recent years, the “dot-in-circle” sign has emerged as a highly specific indicator of mycetoma on Ultrasound (USG) and Magnetic Resonance Imaging (MRI), allowing for non-invasive and early diagnosis [3]. This unique sign has demonstrated the value of USG and MRI in diagnosing mycetoma at an early stage. USG, being a more affordable and widely available imaging modality, can be used as the first-line approach to confirm the diagnosis.

Mycetoma is a localised granulomatous infection of subcutaneous tissue caused by actinomycetes (actinomycetoma) or fungi (eumycetoma), commonly seen in Africa and Asia [4]. Without timely intervention, mycetoma can result in lifelong disabilities [5-7].

Radiological imaging, including Conventional Radiograph (CR), USG, MRI, and Non-Contrast Computed Tomography (NCCT), is necessary to assess the extent of the lesions and aid in surgical planning [7,8]. CR is performed to determine if there is involvement of the bone, as non-surgical treatment becomes challenging in such cases [8]. Advanced mycetoma can be identified on CR by radiological markers such as bone erosions, cavities, periostitis, bony sclerosis, and soft tissue edema [3]. USG is a more specific imaging modality than CR for detecting mycetoma and is commonly used in its diagnosis [9]. The “dot-in-circle” sign on MRI is characterised by a dot representing T2 hypointense (dark signal) fungal or actinomycete grains, and a circle denoting the peripheral T2 hyperintense (bright signal) abscess or granuloma with a thin peripheral hypointense line representing fibrous matrix [Table/Fig-9a]. The comparable USG “dot-in-circle” sign consists of circular hypoechoic lesions with a hyperechoic centre [Table/Fig-9b] [3].

Inflammatory tissue appears on MRI as groups of small (2 to 5 mm) spherical hyperintense lesions with hypointense centre that

are surrounded by a thin dark (low-signal) ring that represents the intervening fibrous septa. A mycetoma appears to be strongly suggested by the “dot in circle” indicator [3,7]. MRI can better delineate the subcutaneous fat, bones, and muscle involvement precisely and thus can grade the disease, which affects the patient’s management [9]. The differentials for the “dots” are phlebolith of haemangioma, though, clinical presentation, scarcer number of the dots, nonappearance of sinuses or inflammation in surrounding tissues favours the finding of slow flow vascular pathology. Other differentials are rice bodies in the fluid of joint or tendon infection, exclusively in tuberculosis or Rheumatoid patients [3]. By using a CT scan, the bone involvement in mycetoma can be evaluated.

CR and USG imaging are suitable for local settings and are particularly useful in low-income countries. In advanced cases with bone involvement, surgical intervention is required for a therapeutic cure [5]. Timely diagnosis of mycetoma is crucial to prevent functional impairment [10].

On USG, eumycetoma lesions appear as abundant sharp bright hyper-reflective echoes parallel to the dark grains, while actinomycetoma lesions show less discrete echoes due to smaller size and consistency [11]. The “Welsh regimen,” which combines co-trimoxazole with amikacin in one to five-week cycles, has been suggested for use in resistant disease. Modifications of the original Welsh regimen may include adding rifampicin, dapson, or increasing the number of cycles in cases of bony erosion [12]. Oral itraconazole (400 mg divided into two doses for six months to three years) is the most commonly used treatment for eumycetoma. Oral antifungal therapy followed by surgical debridement is the preferred approach for treating eumycetoma [13]. For a detailed comparison between actinomycetoma and eumycetoma, refer to the related articles and the provided tables [Table/Fig-10, 11] [14-19].

Study (year), journal	Title	Number, age and complaint of foot	Investigations	HPE	Treatment and outcome
1. Present case series	Three cases of Madura foot with a characteristic ‘dot in circle’ sign, Radiologist perspective	1 st 23 y F, swelling and discharging sinuses 2 nd 60 y M, swelling sinuses 3 rd 36 y M, swelling sinuses	CR, USG, MRI (dot in circle sign)	1. Actinomycetoma 2. Eumycetoma 3. Actinomycetoma	1. Antimicrobial therapy and surgery 2. Antifungal and surgery 3. Antimicrobial therapy Complete cure in all three
2. Kuzucular E et al., [14] (2022)	Mycetoma (Madura foot): A Case Report of a Rare Tropical Disease in Turkey	32 y male, painless swelling in the right foot	MRI (dot in circle sign)	Eumycetoma	Extensive resection result in cure
3. Sahu BK and Nag HL [15] (2021)	An Illustrative Report of Three Cases of Madura Foot with Diagnostic and Treatment features	1 st 54 y M, swelling and discharging sinuses for 8 y 2 nd 60 y M, same complain for 12 y 3 rd 40 y M, same complaints	CR and MRI (dot in circle sign)	Eumycetoma Actinomycetoma	1. Itraconazole 400 mg daily for 8 months and advised surgery but refused 2. Same as above with surgical debulking followed by oral antifungal 3. Same medical therapy for 12 months with cure
4. Wang SS [16] (2020)	Madura foot in a developed tropical country	45 M, verrucous swelling discharge and pain for 8 y	MRI (dot in circle sign)	Actinomycetoma	Antimicrobial (amikacin sulfate in combination with co-trimoxazole) and surgical debulking planned but lost to follow-up
5. Javed F et al., [17] (2017)	Dot-in-Circle Sign-A Diagnostic MRI Sign for “Madura Foot”	58 y M, swelling discharging sinuses for 10 y	CR and MRI (dot in circle sign)	Actinomycetoma	Antimicrobial (amikacin sulfate in combination with co-trimoxazole) and surgical debulking planned but lost to follow-up
6. Neelakantan S et al., [18] (2016)	‘Dot in circle sign’: a characteristic finding in US and MR imaging of soft tissue mycetomas	36 y M, swelling for 2 y	CR,USG, MRI (dot in circle sign)	Eumycetoma	Oral Itraconazole for 12 months resulted in a cure

[Table/Fig-10]: Comparative table between present study and similar articles in recent years [14-18].

Features	Actinomycetoma	Eumycetoma
Causative organism	Filamentous bacteria	True fungi
Epidemiology	With abundant rainfall	In drier areas
Course of disease	Rapidly progressive, with more destruction	Slowly progressive
Size and colour of grains	Fine, white, yellow or red	Coarse, black or pale
Conventional Radiography (CR)	Early bone involvement. Smaller but more numerous cavities, leading to a moth-eaten appearance	Few cavities in the bone that are ≥ 1 cm in diameter
Muscle involvement	May be present	Uncommon
Ultrasound	The grains are fine, hazy, closely aggregated and commonly settle at the bottom of the cavities	The grains are many and they appear as very sharp hyperechogenicity. Single or multiple, hypoechoic, thick-walled cavities with no acoustic enhancement
Histopathology	Grains of bacteria in the background of granulomatous reaction. Gram stain positive	Grains of fungal hyphae in the background of granulomatous reaction. Periodic acid-Schiff, Gomori methenamine silver and lactophenol blue stain positive
Treatment	Antibiotics with or without surgery	Antifungals with or without surgery

[Table/Fig-11]: Differences between eumycetoma and actinomycetoma [19].

CONCLUSION(S)

Ultrasound (US) and Magnetic Resonance Imaging (MRI) complement each other in the early diagnosis and confirmation of Madura's foot, characterised by the "dot-in-circle" sign on imaging. These imaging modalities are quick, non-invasive, and simple to use for early diagnosis and assessing the extent of the lesion. While microbiological culture and biopsy are reliable diagnostic methods, they are time-consuming. In one of our patients, cytology and culture yielded false negative results, highlighting the diagnostic accuracy of low-cost and readily available USG imaging for making the diagnosis and initiating timely treatment with favourable clinical outcomes.

Contributors: All authors contributed to the case report. Dr. Mehtab Ahmad and Dr. Sadaf Sultana were involved in the patient's diagnostic workup and management.

REFERENCES

- [1] Karrakchou B, Boubnane I, Senouci K, Hassam B. Maduraella mycetomatis infection of the foot: A case report of a neglected tropical disease in a non-endemic region. *BMC Dermatology*. 2020;20(1):01-07.
- [2] Alam K, Maheshwari V, Bhargava S, Jain A, Fatima U, ul Haq E. Histological diagnosis of madura foot (mycetoma): A must for definitive treatment. *Journal of Global Infectious Diseases*. 2009;1(1):64-67.
- [3] Sen A, Pillay RS. Case report: Dot-in-circle sign-An MRI and USG sign for. *Indian Journal of Radiology and Imaging*. 2011;21(04):264-66.
- [4] Nenoff P, Van de Sande WW, Fahal AH, Reinell D, Schöfer H. Eumycetoma and actinomycetoma-an update on causative agents, epidemiology, pathogenesis, diagnostics and therapy. *Journal of the European Academy of Dermatology and Venereology*. 2015;29(10):1873-83.
- [5] Salim AO, Mwita CC, Gwer S. Treatment of Madura foot: A systematic review. *JBI Evidence Synthesis*. 2018;16(7):1519-36.
- [6] Reis CM, Reis-Filho EG. Mycetomas: An epidemiological, etiological, clinical, laboratory and therapeutic review. *Anais Brasileiros de Dermatologia*. 2018;93(1):08-18.
- [7] Suleiman SH, Wadaella ES, Fahal AH. The surgical treatment of mycetoma. *PLoS Neglected Tropical Diseases*. 2016;10(6):e0004690.
- [8] Jain V, Makwana GE, Bahri N, Mathur MK. The "dot in circle" sign on MRI in maduramycosis: A characteristic finding. *Journal of Clinical Imaging Science*. 2012;2(1):66.
- [9] Omer RF, Seif EL Din N, Abdel Rahim FA, Fahal AH. Hand mycetoma: The Mycetoma Research Centre experience and literature review. *PLoS Neglected Tropical Diseases*. 2016;10(8):e0004886.
- [10] Asly M, Rafaoui A, Bouyermane H, Hakam K, Moustamsik B, Lmidmani F, et al. Mycetoma (Madura foot): A case report. *Annals of Physical and Rehabilitation Medicine*. 2010;53(10):650-54.
- [11] Van de Sande WW, Fahal AH, Goodfellow M, Mahgoub ES, Welsh O, Zijlstra EE. Merits and pitfalls of currently used diagnostic tools in mycetoma. *PLoS Neglected Tropical Diseases*. 2014;8(7):e2918.
- [12] Scolding P, Fahal A, Yotsu RR. Drug therapy for Mycetoma. *The Cochrane Database of Systematic Reviews*. 2018;2018(7):CD013082.
- [13] Yadlapati S, Chaudhari SP. Eumycetoma. *InStatPearls [Internet]* 2022 Aug 8. StatPearls Publishing.
- [14] Kuzucular E, Eren A, Isik E, Ozden F. Mycetoma (Madura foot): A case report of a rare tropical disease in Turkey. *The International Journal of Lower Extremity Wounds*. 2023;15347346231156642.
- [15] Sahu BK, Nag HL. An illustrative report of three cases of Madura foot with diagnostic and treatment features. *Journal of Orthopaedic Case Reports*. 2021;11(11):74-78.
- [16] Wang SS. Madura foot in a developed tropical country. *International Journal of Infectious Diseases*. 2020;101:312-13. Doi: 10.1016/j.ijid.2020.10.025.
- [17] Javed F, Nazir R, Sharma M, Yasir S, Babar S. Dot-in-Circle sign-a diagnostic MRI sign for "Madura Foot". *J Coll Physicians Surg Pak [Internet]*. 2017 Mar 1.
- [18] Neelakantan S, Babu AA, Anandarajan R. 'Dot in circle sign': A characteristic finding in ultrasound and MR imaging of soft tissue mycetomas. *Case Reports*. 2016;2016:bcr2016216502
- [19] Yadav T, Meena VK, Shaikh M, Khera S, Sureka B, Garg P, et al. Clinic-radiological-pathological correlation in eumycetoma spectrum: Case series. *Northern Clinics of Istanbul*. 2019;7(4):400-06.

PARTICULARS OF CONTRIBUTORS:

1. Assistant Professor, Department of Radiodiagnosis, Era's Lucknow Medical College, Aligarh, Uttar Pradesh, India.
2. Associate Professor, Department of Radiodiagnosis, Jawaharlal Nehru Medical College, Aligarh, Uttar Pradesh, India.
3. Junior Resident, Department of Dermatology, Jawaharlal Nehru Medical College, Aligarh, Uttar Pradesh, India.
4. Ex-Senior Resident, Department of TB and Chest, Jawaharlal Nehru Medical College, Aligarh, Uttar Pradesh, India.
5. Undergraduate Student, Department of Radiodiagnosis, Jawaharlal Nehru Medical College, Aligarh, Uttar Pradesh, India.

NAME, ADDRESS, E-MAIL ID OF THE CORRESPONDING AUTHOR:

Sadaf Sultana,
Flat No. 305, IT Grand Apartment, Zakariya Market, Medical Road,
Aligarh-202001, Uttar Pradesh, India.
E-mail: drsadafsultana@gmail.com

AUTHOR DECLARATION:

- Financial or Other Competing Interests: None
- Was informed consent obtained from the subjects involved in the study? Yes
- For any images presented appropriate consent has been obtained from the subjects. Yes

PLAGIARISM CHECKING METHODS: [Jain H et al.]

- Plagiarism X-checker: Mar 22, 2023
- Manual Googling: May 20, 2023
- iThenticate Software: Jun 17, 2023 (11%)

ETYMOLOGY: Author Origin

EMENDATIONS: 6

Date of Submission: Mar 14, 2023

Date of Peer Review: May 08, 2023

Date of Acceptance: Jun 23, 2023

Date of Publishing: Sep 01, 2023