

Sudan University of Science and Technology

College of Graduate Studies

**A Study of Sonographic Findings of Mycetoma Disease among
Sudanese**

دراسة نتائج التصوير بالموجات فوق الصوتية لمرض المايستوما لدى السودانيين

A thesis submitted in Partial Fulfillment for the requirement of M.Sc. Degree
in Medical Diagnostic Ultrasound

By:

Selma Abdelrouf Ahmed Osman

Supervisor:

Dr. Ahmed Mostafa Abukonna

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الاية:

(وَمَا تَوْفِيقِي إِلَّا بِاللَّهِ عَلَيْهِ تَوَكَّلْتُ وَإِلَيْهِ أُنِيبُ)

سوره هود (88)

Dedication

To my mother

To my brother and my sister

To my husband

To my daughters and my son

Acknowledgment

My deepest appreciation and sincerest gratitude to Dr. Mustafa Alhour who helped me in data collection much thanks for him. My supervisor Dr. Ahmed Abukonna for his contribution and guidance.

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List of abbreviations

Abbreviation	Full meaning
C	Centgrate
MHZ	Mega herz

Abstract

Mycetoma is a common health problem, endemic in many tropical and subtropical region characterized by devastating deformities, disability and high morbidity. The Sonographic appearance of Mycetoma is described in this prospective study. 60 patients with soft tissue swellings had Sonographic evaluation of the swelling and surgical excision within 2 weeks of ultrasonography.

The result of the study revealed that Mycetoma affected males more than females especially agriculture workers who had suffered minor skin injuries. Mycetoma was detected by ultrasound in 58 patients with percent (96.7%) and not detected in 2 patients with percent (3.3%); the common site was foot (70%). Regarding the differentiation of Mycetoma, the study showed that Euomycetoma was seen in 52 patients (86.7%) and actinomycetoma was seen in 8 patients (13.3%). Furthermore, in Eumycetoma the vascularity was detected in 20 patients (38.5%) while in Actionmycetoma vascularity was detected in 7 patients.

Ultrasonography is simple, noninvasive, quick, reproducible and acceptable to patients. Mycetoma has characteristic Sonographic features. Furthermore, ultrasonography delineates the extent of Mycetoma more accurately than clinical examination alone.

المستخلص

المايستوما مشكلة صحية شائعة ، مستوطنة في العديد من المناطق المدارية وشبه المدارية والتي تتميز بتشوهات مدمرة وإعاقة. في هذه الدراسة 60 مريضا يعانون من تورم الانسجة الرخوة تم تقييمهم بالموجات فوق الصوتية.

كشفت نتائج الدراسة أن مرض المايستوما يصيب الذكور أكثر من الإناث وخاصة عمال الزراعة الذين عانوا من إصابات جلدية طفيفة. تم اكتشاف المايستوما عن طريق الموجات فوق الصوتية في 58 مريضا مع نسبة مئوية (96.7 %) ولم يتم الكشف عنها في 2 مريض مع نسبة مئوية (3.3 %) ؛ كان القدم أكثر المناطق اصابة في الجسم بنسبة (70 %). فيما يتعلق بتمايز المايستوما، أوضحت الدراسة أن النوع (ايومايستوما) شوهد في 52 مريضا (86.7 %) وشوهدت (أكتاينومايستوما) في 8 مرضى (13.3 %). اضافة على ذلك ، تم اكتشاف الأوعية الدموية في 20 مريضاً (38.5 %) في (ايومايستوما) بينما تم اكتشاف الأوعية الدموية في (أكتاينومايستوما) في 7 مرضى.

التصوير بالموجات فوق الصوتية بسيط و سريع و قابل للتكرار ومقبول من قبل المرضى. اضافة على ذلك ، إن الموجات فوق الصوتية تحدد مدى ورم الخلايا الورمية بشكل أدق من الفحص السريري وحده.

Chapter one

Introduction

1.1 Introduction:

Mycetoma is a common health problem, endemic in many tropical and subtropical region characterized by devastating deformities, disability and high morbidity. It is a debilitating disease; it has serious negative medical and socio-economic impacts on patients, families, communities and health authorities (Develoux, 2016).

Mycetoma is a chronic granulomatous subcutaneous inflammatory disease caused by true fungi (eumycetoma) and certain bacteria (actinomycetoma). It affects the poor populations in most remote areas. Typically, young adult male farmers, laborers and students between 15-30 years old of low socioeconomic status are affected most. In endemic areas, there is a clear relationship between Mycetoma and individuals who walk bare footed and the field manual workers but no person is exempted (Rao, 2016).

Mycetoma clinical presentation is almost identical irrespective of the causal organism and it is characterized by a triad of painless subcutaneous mass, multiple sinuses and discharge contiguously to involve the skin, deep structures and bone resulting in dissection, disfigurement and loss of function. Mycetoma commonly involves the extremities, back and gluteal region. Mycetoma painless nature. The grain can be black, yellow, white or red according to phases and causative organism (Fihmi et al., 2017).

Mycetoma continues to pose huge public health threat in many tropical and subtropical countries (Zijlstra et al., 2016b). If not detected and managed early, it causes gruesome deformity of the limbs, severe disability, premature termination

of occupation, difficulty in finding jobs and partner among young adults and accelerates the rate of drop outs from school in children (Zijlstra et al., 2016b). Just like leprosy, in which stigma affects many dimensions of victim's life (van't Noordende et al., 2016), Mycetoma is also plagued by various socioeconomic consequences (Zijlstra et al., 2016a). Tough uncertainty hovers on its actual global incidence, a field survey from West Nile State of Sudan, a country uniquely believed to be the most endemic in the world, yielded a prevalence of 14.5/1000 population in 2010 (Fahal et al., 2014). Several autochthonous and imported cases have also been reported from Europe (Gilquin et al., 2016).

Ultrasonic Imaging of Mycetoma Characteristic features include numerous, isolated sharp hyper reflective echoes corresponding to the grains in the lesion in eumycetoma. In actinomycetoma, the grains are less distinct because of their smaller size and consistency. The technique is safe, simple, accurate, and useful in planning surgical treatment. Ultrasonography is simple, non-invasive, quick, reproducible and acceptable to patients. Mycetoma has characteristic Sonographic features, Furthermore, ultrasonography delineates the extent of Mycetoma more (Ramos et al., 2008). The purpose of this study was to study the Sonographic findings of different Mycetoma types.

1.2 Problem of study:

The Mycetoma lesion its capsule and accompanying inflammatory granuloma have characteristics sonographic appearance. This study will discuss if high frequency ultrasound imaging with color Doppler can differentiate between Mycetoma and other non Mycetoma lesions and differentiate between eumycetoma and actinomycetoma.

1.3 Objective of the study:

1.3.1 General objective:

The general objective of this research was to study the sonographic findings of Mycetoma.

1.3.2 Specific objective:

- To detect the Mycetoma lesion by ultrasound.
- To characterize the two types of Mycetoma.

1.4 Over view of the study:

The study is consisted of five chapters, with chapter one was an introduction which include: problem of the study and objectives of the study. Chapter two well present comprehensive literature review. Chapter three was methodology which includes material used to collect the data and method of data acquisition and analysis. Chapter four includes presentation of the results using tables and figures, finally chapter five included discussion, conclusion and recommendations.

Chapter tow

Literature review and theoretical background

2.1 Epidemiology and Etiology:

Although mycetoma is found world wide, its exact incidence is unknown because of the slow, chronic nature of the disease and its presentation by the majority of individuals with the condition. Mycetoma is endemic in tropical and subtropical areas, and the majority of disease occurs in the mycetoma belt which stretches between the latitudes of 15 south and 30 north within this belt are countries such as Sudan ,Somalia ,Senegal, India ,Yemen , Mexico , Venezuela,Colombia and Argentina (Fahal et al., 2014).Regions in the mycetoma belt are characterized by short rainy seasons with fairly consistent daily temperatures (30-37)° C and relative humidity of 12-18% . These alternating weather conditions may contribute to the survival of the causative organisms while the most Mycetomais limited to these regions(Fahal et al., 2018).

Mycetoma is more common in individual who have more frequent and direct contact with the field environment, such as farmers, herdsman and other field laborers. Males are more likely to be affected than females, with the ratio ranging from approximately 3:1 to 5:1. (Emmanuel et al., 2018).

The most common cause of mycetoma a worldwide is eumycetes,particularly *Madurella mycetomatis*,which causes more than 70% of cases in certain regions of central Africa including Sudan(Fahal et al., 2014). Mycetoma reported 1231 cases occurring over a 2-5 years period in Sudan. Other causative organism is *Actinomyces Nacordiabasilensis*, *Streptomyces somoliensis*(Samy et al., 2014).

2.2 Pathogenesis:

Mycetoma is categorized as subcutaneous infection because it is primarily limited to subcutaneous tissues and dermis with minimal, rare systemic disease. All subcutaneous mycetoma are caused by fungi or bacteria that enter the skin via a penetrating injury, often a thorn prick or splinter. Recently, this route has been disputed because of case reports lacking a history of trauma. The incubation period for the disease is variable and not well defined, some individuals present with symptoms lasting several weeks and others with symptoms lasting years. Often the patient's exact recall of the trauma is not reliable. Furthermore, these details are difficult to investigate because of late presentation by patients (after obvious draining or swelling) lack of accessible health care facilities and fear of amputation (Fahal et al., 2014).

2.3 Clinical presentation:

The characteristic clinical trial for mycetoma is swollen tissue, draining sinuses, and identification of grains from discharge. Initially some individuals may report a feeling of pain or discomfort at the site, while others may not recall any direct trauma. Inoculation is followed by development of a painless subcutaneous nodule that spreads slowly. Usually this nodule is round and firm, but it may also be soft, lobulated or rarely cystic (Fihmi et al., 2017).

As the nodule increases in size, secondary nodules and papules may develop with accompanying sinuses that drain serous, serosanguineous, or purulent discharge. Over time, some of the sinuses close and heal, while new ones form. The overlying skin may be shinier with local hyperhidrosis and is usually hyperpigmented but may also be hypopigmented (Relhan et al., 2017).

Abscesses occur under the surface of the skin and as the disease progresses, the lesions extend in to bony tissue ,causing small cavities (2-10mm)to develop .if un treated , bony involvement can be extensive and devastating , leading to complete bone destruction .much later and more rarely in the disease, lesions may affect nerves and tendons .local lymph adenopathy is common with small and Shorty lymph nodes ,and may result from secondary bacterial infection , spread of mycetoma(Fahal et al., 2014).



Figure (2-1) Characteristic swollen foot with drain sinuses in a patient with mycetoma(Fahal et al., 2014)



Figure (2-2) Redness papules accompanying sinuses drain serous in hand mycetoma(Ali et al., 2009)

2.4 Site of mycetoma infection

Common sites were:

1-Feet (70-80%)

2-Hands(12%)

3-Legs

4-Kneejoints

Highly endemic regions:

- Arm
- Head/neck
- Thigh /trunk

Rare in:

- Chest
- Abdominal wall
- Facial bones
- Mandible
- Paranasal sinuses
- Orbit
- Scrotum (Efared et al., 2017)



Figure (2-3) Patient with yellowish white pustules and redness of trunk mycetoma lesion(Ali et al., 2009)

2.5Diagnosis:

Microscopy and culture of exudates and skin biopsy for pathology are necessary to identify the causative organism. DNA sequencing has been used for identification in difficult cases. Plain x –Ray are used to assess the evidence of bone involvement .CT scan and MRI can provide a better assessment of the degree of bone and soft tissue involvement and may be use full in evaluating the differential diagnosis of swelling .Ultra sound is very use full in detect the grains so can detect small legions (Wang et al., 2019).

2.6 Differential diagnosis:

The main differential diagnosis is chronic bacterial osteomyelitis, tuberculcers. Other deep fungal infection such as blastomycosis or coccidiomycosisleishmaniasis(Ali et al., 2009)

2.7Complications:

The disease causes disfigurement but is rarely fetal. In advanced cases, deformities may occur.Chronic neglected infection may necessitate amputation. Lymphatic obstruction and fibrosis may cause lymphoedema .Complications may result also from toxicity due to prolonged anti-microbial or anti-fungaltherapy (Ali et al., 2009).

2.8 Clinical differences between Actinomycetoma and Eumycetoma:

	Actinomycetes	Eumycetes
Causative organism	Bacteria	Fungi
Clinical lesion	Diffuse with no clear margin	Well encapsulated with well-defined margin
Sinuses	Many	Few
Color of grains	Various ,but not black	Various ,but mostly white or black
Course of infection	Inflammatory with rapid progression	Slowly progressive
Bony involvement	Rapid	After a long period of time
Ultrasonic imaging	Grains are less distinct as compared with eumycetes	Numerous, sharp, bright, hyper reflective echoes. Multiple,thick walled cavities with absent acoustic enhancement
Cavities in radiograph	Numerous ,small in size	Small in number but large in size, with clear margins
Management of choice	Medical treatment (anti-bacterial drugs)	Medical (anti-fungal) and surgical intervention required

(Aichouni et al., 2018)

2.9 Sonographic imaging of mycetoma:

The mycetoma lesion, its capsule and accompanying inflammatory granuloma have characteristic ultrasonic appearances.

- In eumycetes lesions the grains produce numerous sharp bright hyper reflective echoes which are consistent with black grains. The grain cement substance is most probably the origin of these sharp echoes.

In addition, there are multiple thick walled cavities with absent acoustic enhancement (Ali et al., 2009).



Figure (2-4) fungal type of mycetoma (eumycetoma). The patient had multiple pockets. There are hyper echoic granules with hypo echoic areas around it (Ali et al., 2009).

- In Actinomycetoma lesion, the findings are similar but the grains are less distinct. This may be due to their smaller size and consistency, individual

embedding of the grains or the absence of the cement substances in few of them (Ali et al., 2009).

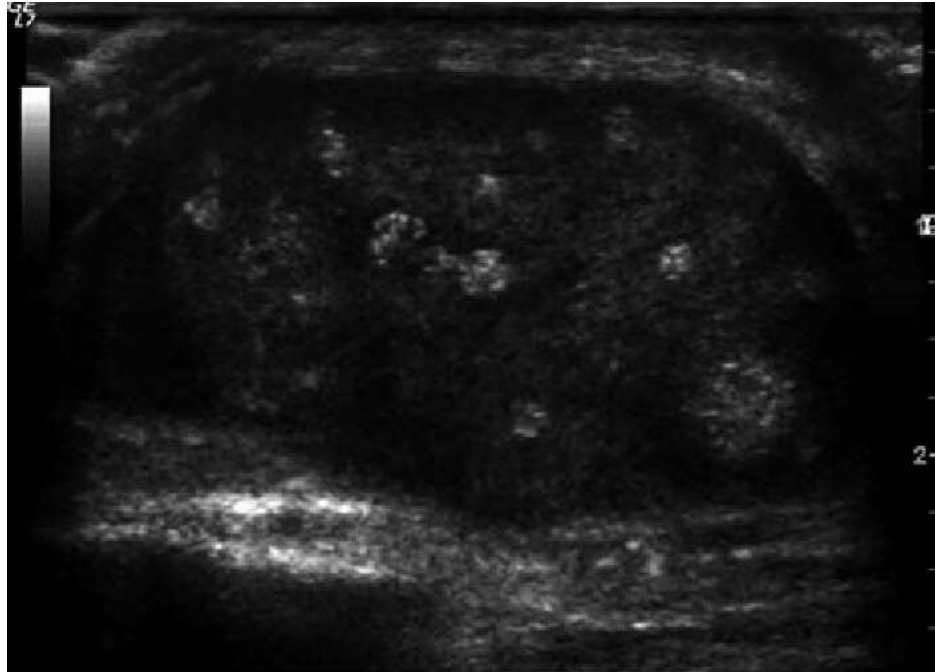


Figure (2-5) Bacterial type of mycetoma (action mycetoma) a lesion with multiple granules, less fluid content, outline more prominent (Ali et al., 2009)

2.10 Pervious study:

(Fahal et al., 1997) conducted study in One hundred patients with foot swellings had Sonographic evaluation of the swelling and surgical excision within 2 weeks of ultrasonography. The histopathological findings were compared with the preoperative images. Some of the excised swellings and grains were also imaged and compared with the in vivo findings. The result showed that mycetoma grains, their capsules and the accompanying inflammatory granulomas have characteristic

ultrasonographic appearances. In eumycetoma lesions, the grains produce numerous, sharp hyperreflective echoes and there are single or multiple thickwalled cavities with no acoustic enhancement. In actinomycetoma, the findings are similar but the hyperreflective echoes are fine, closely aggregated and commonly settle at the bottom of the cavities. None of the nonmycetoma foot swellings (which included lipoma, ganglion, foreign body granuloma and others) studied had these features.

Another study conducted by (Adam et al., 2014), the main findings of this study show the foot mycetoma more common in males (76%), most common affected age intervals (21-30) years, 32 cases, and (31-40) years (32%), the most common area from Aljazeera state (57%) and the fungal type (78%) is more than bacterial type (22%). The study revealed that the major of the patients were workers 61 (61%). The types of Mycetoma were, 22 (22%) actinomycetoma and 78 (78%) were Euomycetoma. Ultrasound appearance of Mycetoma with Grain 51(51%).It was found that 67 (67%) with intact, and verified that the ultrasound examination of foot mycetoma is simple, reproducible, and low cost. The study concluded that ultrasound and Doppler has high efficiency in diagnosing mycetoma with high accuracy in diagnosis of mycetoma and even in differential diagnosis of its types. It must be used as first diagnostic tool.

Chapter Three

Materials and Method

3.1 Materials:

3.1.1 Subjects:

The sample of the study was 60 patients (15 female and 45 male) their age ranged between (16-67) years old with soft tissues masses.

3.1.2 Machine used:

High quality ultrasound machine type (Aloka ssd 3500) with high frequency transducer (7.5 MHz) and color Doppler capability.

3.2 Method:

3.2.1 Technique used:

Patient prone on bed, foot flexed with toes on the bed for support. Place the probe over the midline of the heel on the plantar aspect. The toe of the probe towards the heel. Scan in longitudinal and transverse over the plantar aspect of the metatarsophalangeal joints. Scan the plantar fascia distal longitudinal and transverse Flexor hallucis longus tendon transverse and longitudinal. The plantar fascia appears as a fibrillar structure inserting onto the calcaneum. It should be flat and homogenous. To scan mid foot; follow the plantar fascia into the arch and look for fusiform, and nodular thickenings. Each metatarsophalangeal joint scan in different position to assess the extensor then flexor. Scan in longitudinal over the plantar aspect of the metatarsophalangeal joints. The plantar plate is readily seen as

a homogeneous elongated wedge arising from the base of the proximal phalanx extending under the head of the metatarsal.

3.2.2 Data collection and analysis:

Data were collected randomly using data collection sheet and statistical analysis was performed statistical package for social sciences (SPSS). Statistical significance was determined by Chi square test, correlation used $p > 0.05$ is considered. Cross tabulation and frequency table, mean, standard deviation measured variables will be computed.

Chapter four

Results

3.1 Results:

Table (4-1) shows descriptive statistic of age

	N	Minimum	Maximum	Mean	Std. Deviation
Age	60	16	67	40.22	16.499

Table (4-2) shows frequency and percent of gender

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Male	45	75.0	75.0	75.0
	Female	15	25.0	25.0	100.0
	Total	60	100.0	100.0	

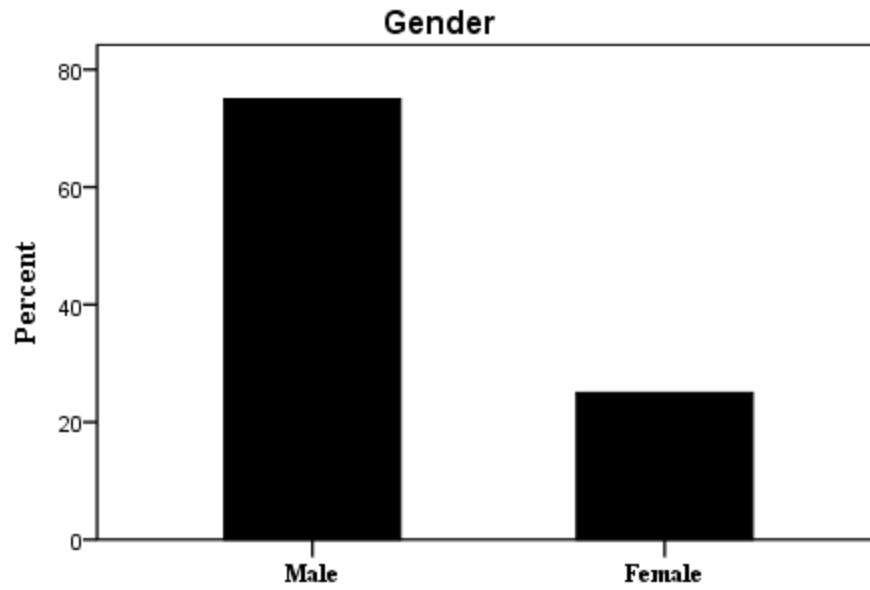


Figure (4-1) shows distribution of male and female

Table(4-3) shows frequency and percent of Detection

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	58	96.7	96.7	96.7
	NO	2	3.3	3.3	100.0
	Total	60	100.0	100.0	

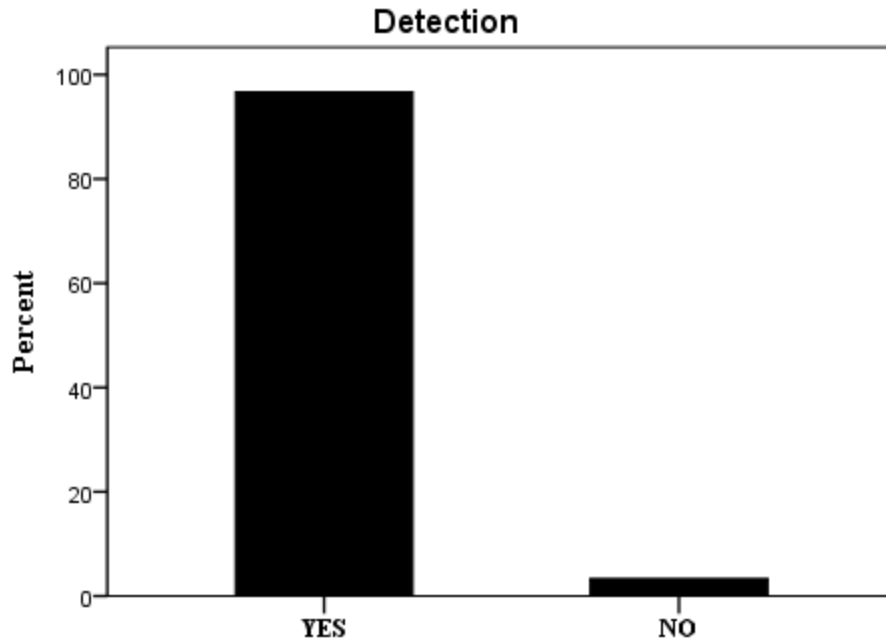


Figure (4-2) shows the bar chart for the distribution of capability detection

Table (4-4) shows frequency and percentage of Differentiation (Euo or Actino)

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	EUO	52	86.7	86.7	86.7
	Actino	8	13.3	13.3	100.0
	Total	60	100.0	100.0	

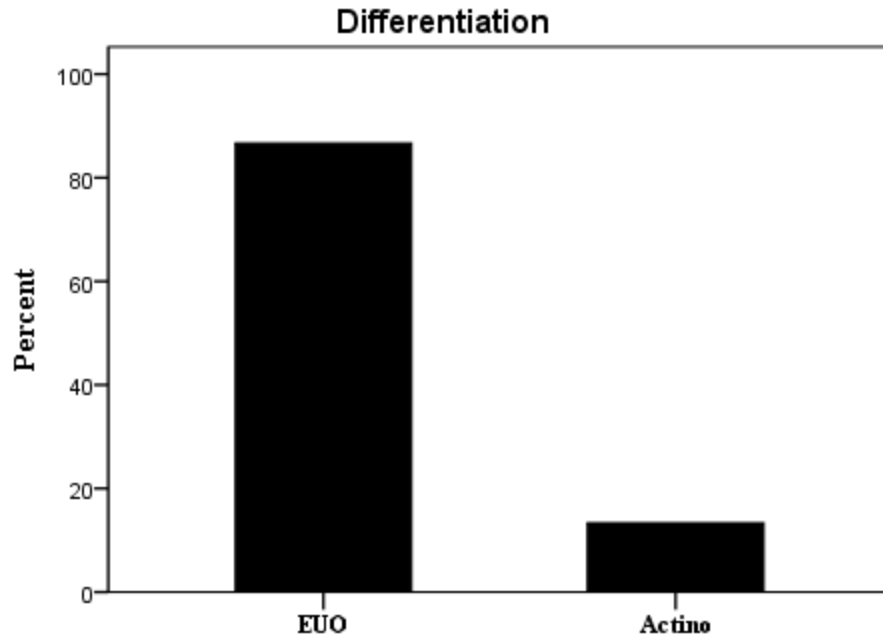


Figure (4-3) shows bar chart for the distribution of Differentiation of types of Mycetoma

Table (4-5) shows frequency and percentage of sites of mycetoma

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	Foot	42	70.0	70.0	70.0
	Knee	8	13.3	13.3	83.3
	Leg	6	10.0	10.0	93.3
	Hand	2	3.3	3.3	96.7
	Gluteal	1	1.7	1.7	98.3
	Femur	1	1.7	1.7	100.0
	Total	60	100.0	100.0	

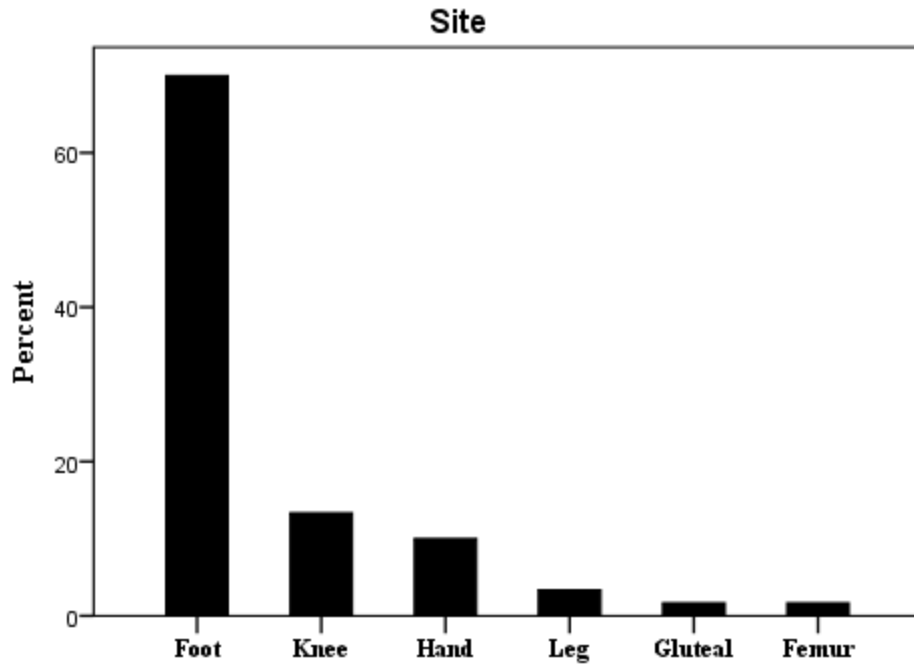


Figure (4-4) shows distribution of the site of mycetoma

Table (4-6) shows frequency and percentage of vascularity

		Frequency	Percent	Valid Percent	Cumulative Percent
Valid	YES	27	45.0	45.0	45.0
	NO	33	55.0	55.0	100.0
	Total	60	100.0	100.0	

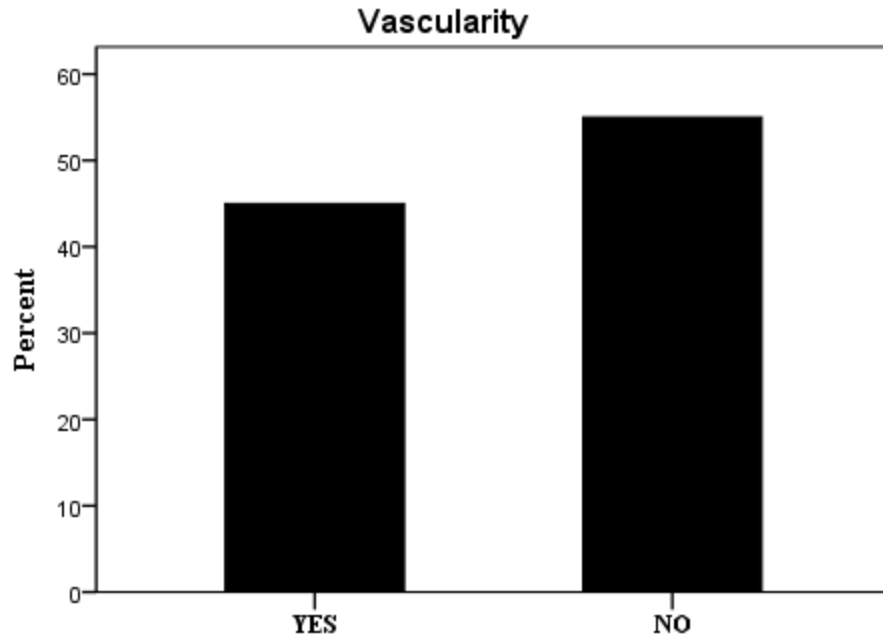


Figure (4-5) shows distribution of vascularity

Table (4-7) shows vascularity *Differentiation crosstabulation

Vascularity * Differentiation Crosstabulation					
			Differentiation		Total
			EUO	Actino	
Vascularity	YES	Count	20	7	27
		% within Differentiation	38.5%	87.5%	45.0%
	NO	Count	32	1	33
		% within Differentiation	61.5%	12.5%	55.0%
Total		Count	52	8	60
		% within Differentiation	100.0%	100.0%	100.0%

Table (4-8) show site * vascularity crosstabulation

			Vascularity		Total	
			YES	NO		
Site	Foot	Count	20	22	42	
		% within Site	47.6%	52.4%	100.0%	
	Knee	Count	3	5	8	
		% within Site	37.5%	62.5%	100.0%	
	Hand	Count	1	5	6	
		% within Site	16.7%	83.3%	100.0%	
	Leg	Count	1	1	2	
		% within Site	50.0%	50.0%	100.0%	
	Gluteal	Count	1	0	1	
		% within Site	100.0%	0.0%	100.0%	
	Femur	Count	1	0	1	
		% within Site	100.0%	0.0%	100.0%	
	Total		Count	27	33	60

Chapter five

Discussion, conclusion and recommendation

5.1 Discussion:

The study was conducted on 60 patient with minimum age 16 and maximum age 67, the mean was 40 years old. Frequency of male was 45 (75%) and female was 15 (25%). It was clear that Mycetoma affected males more than females especially agriculture workers who had suffered minor skin injuries, this result was in line with the previous studies (Adam et al., 2014, Fahal et al., 1997).

Mycetoma was detected by ultrasound in 58 patients with percent (96.7%) and not detected in 2 patients with percent (3.3%). Regarding the differentiation of Mycetoma, the study showed that Eumycetoma was seen in 52 patients (86.7%) and actinomycetoma was seen in 8 patients (13.3%). This result was in accordance with the previous study which stated that eumycetoma was the common type in Africa and India (Zijlstra et al., 2016a).

Concerning the site of Mycetoma, the result showed the distribution as follows: Foot 42 patients (70%), knee 8 patient (13.3%), leg 6 patients (10%), hand 2 patients (3.3%), gluteal 1 patient (1.7%) and femur 1 patient (1.7%). Since the common type of Mycetoma was Eumycetoma, the common site was foot because it is mainly affected the foot (Fahal, 2004, Zijlstra et al., 2016b).

The vascularity was detected in 27 patients (45%) and not detected in 33 patients (55%). In Eumycetoma, the vascularity was detected in 20 patients (38.5%) and not detected in 32 patients (61.5%). In Actinomycetoma vascularity was detected in 7 patient (87.5%) and not detected in 1 patient (12.5%) of all Actinomycetoma

patient. It has been noted that from previous studies the vascular circulation in Mycetoma is adequate and probably, however the difference in the flow of the two types of Mycetoma can be attributed to the presence of a capsule and dense fibrosis in eumycetoma compared with that seen in actinomycetoma (Fahal et al., 1997).

Ultrasound with high frequency transducer is very effective and accurate; it must be used as the first tool, Doppler u/s is important for accurate diagnosis of Mycetoma.

5.2 Conclusion:

This study was conducted to detect and differentiate of Mycetoma by using high frequency ultrasound. Mycetoma was detected in 58 patients (96.7%) and not detected in 2 patients (3.3%) of all population. So ultrasound is very accurate in detection of Mycetoma. Eumycetoma was more common type and the foot was the common site of Mycetoma (70%). Vascularity of Mycetoma was detected in 27 patients (45%) and not detected in 33 patients (55%). So high frequency ultrasound and color Doppler is very accurate in detection Mycetoma and differentiate the two types of Mycetoma.

5.3 Recommendations:

- Ultra sound with color Doppler and high frequency transducer should be available at any center of Mycetoma because its available,cheape,repeatable,acceptable.
- Further studies with larger sample size should be conducted.
- There is only one mycetoma center in sudan in Khartoum state somycetoma center should be available in any region in sudan .

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Appendices

Data sheet

No	Gender	Age	Detection of mycetoma	Differentiation (Eu –Actino	Site	Vascularity

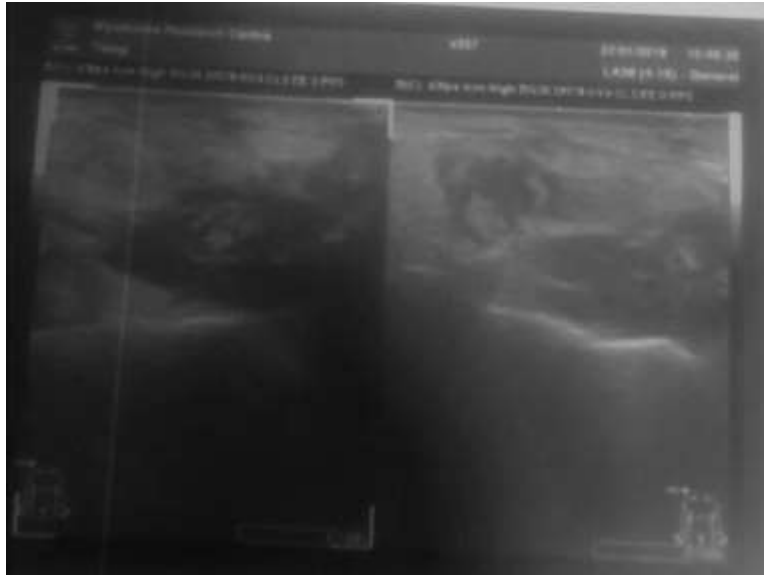


Image 1: 20years old male patient with Actinomycetoma small reflective grains

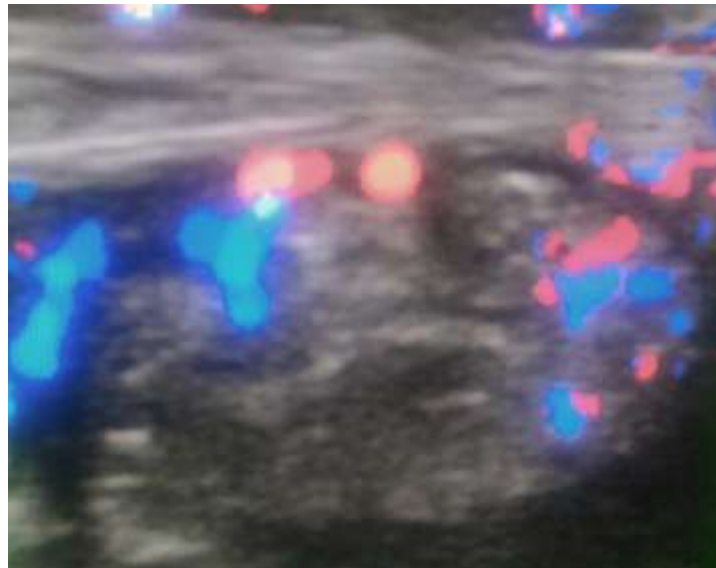


Image 2: Vascularity of Mycetoma lesion in 67 years old male



Image 3: 41 years old male patient with Eumycetoma, sharp bright hyper reflective echoes, thick wall cavities