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Radiologically Advanced Pulmonary Tuberculosis in Mogadishu, Somalia: A Review of 206 Cases with Acid Fast Bacilli Smear-Positive Sputum

Mogadişu, Somali'de Radyolojik Olarak İlerlemiş Akciğer Tüberkülozu: Balgam Yayması Aside Dirençli Basil Pozitif 206 Vakanın İncelenmesi

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Abstract

Tuberculosis (TB) is an important public health problem worldwide and in Somalia and is a significant cause of death and disease burden due to untreated advanced cases. Despite its prevalence in the country, limited awareness of TB (including healthcare professionals) is one of the most important reasons for underdiagnosis and one of the most important obstacles to achieving the targets of fighting TB in Somalia. In this study, it was aimed to document the radiological signs of pulmonary TB in 206 patients with radiological imaging results among the patients (n=220) who applied to a tertiary hospital serving in Mogadishu and were found to have a positive sputum smear result. The study includes retrospective evaluations of X-ray radiographs of 155 patients and computed tomography (CT) images of 51 patients. Of the 206 patients included in the study, 73.3% (n=151) were male and 26.7% (n=55) were female, and the average age of the study group was 38.5±18.99 years (age range was 3-90 and median was 32, patients were 16 and over, except for a three-year-old child). In patients who are all HIV (human immunodeficiency virus) negative, the most common radiological findings are; nodular opacities were determined as (76.2%), patchy infiltration (62.1%), cavitation (46.1%) and consolidation (45.1%). The majority of the patients were newly diagnosed TB patients, and 14.8% (23/155) of the patients for whom data was available were patients with a history of TB. However, radiological findings showed that the majority of patients had postprimary TB infections. According to accessible retrospective records, 89.3% of the patients had cough, 83.3% had sputum production, and 83.2% had chest pain. Considering the distribution of the lesions, 50.3% of the patients with X-ray results and 70.6% of the patients with CT results had bilateral involvement. The upper lung zones were most frequently affected in both X-ray (81.3%) and CT imaging (78.4% and 74.5% for right and left, respectively). In this study, advanced disease findings and permanent damage were observed in a significant portion of the patients, and extra pulmonary spread was also observed in some patients. All these data show that tuberculosis patients in Somalia are diagnosed late and that there are significant disruptions in the treatment process.

Keywords: Pulmonary tuberculosis, Computed tomography, Chest X-ray, Somalia.

Özet

Tüberküloz dünya genelinde ve Somali'de önemli bir halk sağlığı sorunu olup tedavi edilmeyen ilerlemiş olgular nedeni ile önemli bir ölüm ve hastalık yükü nedenidir. Ülkedeki yaygınlığına rağmen tüberküloz için farkındalığın (sağlık çalışanları da dahil olmak üzere) sınırlı olması eksik tanının en önemli nedenlerinden biri olup, Somali'de tüberküloz ile mücadele hedeflerinin tutturulması önündeki en önemli engellerden biridir. Bu çalışmada Mogadişu'da hizmet veren bir üçüncü basamak hastaneye başvuran ve pozitif balgam yayması sonucu bulunan (n=220) hastalardan, radyolojik görüntüleme sonuçları bulunan 206 hastada pulmoner tüberkülozun radyolojik belirtilerini belgelemek amaçlanmıştır. Çalışma 155 hastanın X-Ray grafilerini (göğüs röntgeni) ve 51 hastanın bilgisayarlı tomografi (*computed tomography*, CT) görüntülerine ait retrospektif değerlendirmeleri kapsamaktadır. Çalışmaya dahil edilen 206 hastanın %73.3'ü (n=151) erkek ve %26.7'si (n=55) kadın hastalar olup, çalışma grubunun yaş ortalaması 38.5±18.99 idi (yaş aralığı 3-90 ve ortanca 32, üç yaşındaki bir çocuk dışındaki hastalar 16 ve üzeri yaşlarda idi). Tümü HIV (*human immunodeficiency virus*) negatif olan hastalarda en sık görülen radyolojik bulgular; nodüler opasiteler (%76.2), yamalı infiltrasyon (%62.1), kavitasyon (%46.1) ve konsolidasyon (%45.1) olarak belirlendi. Hastaların çoğunluğunu yeni tanı almış tüberküloz hastaları oluştururken, verilere ulaşılabilen hastaların %14.8'i (23/155) tüberküloz öyküsü olan hastalardı. Bununla beraber, radyolojik bulgular hastaların çoğunluğunun postprimer tüberküloz enfeksiyonları olduğunu göstermekte idi. Erişilebilir retrospektif kayıtlara göre, hastaların %89.3'ü öksürük, %83.3'ü balgam ve %83.2'si göğüs ağrısı şikayetlerine sahipti. Lezyonların dağılımına bakıldığında X-ray sonuçları olan hastaların %50.3'ünde, BT sonuçları olan hastaların ise %70.6'sında bilateral tutulum vardı. Hem X-ray (%81.3) hem de CT görüntülemelerinde (sağ ve sol için sırasıyla %78.4 ve 74.5%) en sık üst akciger zonları etkilenmişti. Bu çalışmada hastaların önemli bir bölümünde ilerlemiş hastalık bulguları ve kalıcı hasarlar izlenmiş olup, bazı hastalarda ekstra pulmoner yayılım da gözlenmiştir. Tüm bu veriler Somali'de tüberküloz hastalarının geç tanı aldığını ve tedavi süreçlerinde önemli aksaklıklar olduğunu göstermektedir.

Anahtar Kelimeler: Akciğer tüberkülozu, Bilgisayarlı tomografi, Akciğer grafisi, Somali.

Introduction

It is estimated that approximately one quarter of the world's population, approximately two billion people, is latently infected with *Mycobacterium tuberculosis* [1,2]. Despite the advances in diagnosis and treatment strategies during the last decades, tuberculosis (TB) remains one of the leading causes of death from infectious diseases worldwide, and the transmission of TB, which infects millions of new people every year, has not yet been effectively prevented [1,3]. According to the World Health Organization (WHO) Global Tuberculosis Report 2022 [4], the annual number of new cases of TB, which was estimated as 10.1 million (95% UI; 9.5-10.7 million) in 2020, reached 10.6 million (95% IU; 9.9-11 million) people in 2021 with an estimated 4.5% increase. It was also estimated that 1.4 million deaths (95% UI; 1.3-1.5 million) occurred among human immunodeficiency virus (HIV)-negative people and 187,000 deaths (95% UI; 158,000-218,000) among HIV-positive people (1.6 million total death) in 2021 [4].

Although African countries have made significant progress against TB in recent years, the African region accounts for 23% of the estimated global TB burden and more than 33% of global TB deaths [5]. Another important problem for the African region is that the number of diagnosed cases is far from reflecting the real burden, as it is estimated that 40% of cases remain undiagnosed or unreported in 2021 [5].

TB is an important public health problem in Somalia and is an important cause of death and disease burden [6–8]. Despite the prevalence of TB in the country, deficiencies in diagnosis and treatment still remain [9]. The 2021 Global TB report indicated that there was a marginal increase in the estimated TB incidence in Somalia, from 258 per 100,000 people in 2018 to 259 in 2020 [9,10]. Somalia is among the countries with the highest death rate in the world, with an annual TB-related death rate of 68 per 100,000 people [9,10]. Also, an estimated 6.2% annual reported TB cases in Somalia have drug-resistant TB [11].

In this study, we aimed to determine the radiological signs of pulmonary TB in acid fast bacilli (AFB) smear-positive patients admitted to a tertiary-care hospital in Somalia.

Material and Method

The study was conducted after obtaining approval from Ethics Committee of Somalia Turkey Recep Tayyip Erdogan Education and Research Hospital, date: 05.12.2019, decision no: 187, number: MSTH/2728, and the study carried out in accordance with the tenets of the Declaration of Helsinki.

Study group and design

Firstly, all patients who applied to Mogadishu Somali Turkey Recep Tayyip Erdoğan Training and Research Hospital with suspected complaints or findings of TB and who tested for AFB in the medical microbiology laboratory during the 4-year period between July 2016-November 2019 were retrospectively investigated as a preliminary study. Of the 220 AFB smear-positive cases (reviewed in detail in a previous study [7] conducted in our hospital), approximately 75% had a chest X-ray and 25% a computed tomography (CT) examinations. The number of patients with any radiological imaging (X-ray and/or CT) was determined as 206. 50 patients had CT, 155 patients had X-ray, and one patient had both X-ray and CT imaging. In order to avoid numerical confusion, only the CT data of the patient who had both X-ray and CT imaging was added to the comparative analyzes and tables, considering that it would not cause a significant change in the results. As a result, our study covers the evaluation of 206 different patients, including CT imaging results of 51 patients and X-Ray imaging results of 155 different patients.

Microscopic evaluation

Microscopic evaluation procedures reviewed in detail in a previous study [7] conducted in our hospital. According to CDC criteria patients' samples were classified as follows; 1-9 bacilli observation in 100 areas was determined as +, 1-9 bacilli in 10 areas as ++, 1-9 bacilli in each area as +++, and over 9 bacilli observed in each area as ++++ [12].

Radiological imaging and evaluation

Radiologic imaging (chest X-ray and CT) of AFB smear-positive patients was evaluated by a radiologist with five years of experience. Chest radiographs were performed in the posteroanterior projection and standing with a floor-mounted digital X-ray machine [13]. CT examinations were performed with a 16-slice MDCT system (Sensation 16; Siemens, Forchheim, Germany) [14]. All CT images were performed in the axial plane with a section thickness of 0.625-1.250 mm, and then sagittal and coronal planes were obtained by multiplanar reconstruction. All images were obtained from the hospital's image archive and communication system (PACS, Fonet Information Technologies, Istanbul, Türkiye.

Statistical analysis

At the end of the study, frequency, mean and standard deviation values were calculated, and comparisons between the groups (gender, method, age groups) were performed using the chi-square and/or Fisher's exact probability test for categorical variables. Fisher's exact test was used when the chi-square test was insufficient due to the sample size. Mann-Whitney U test was used for intergroup comparison of continuous variables that did not comply with normal distribution. The correlation between AFB positivity and the number of radiological lesion types was examined with Spearman correlation analysis. A p value of <0.05 was considered statistically significant (at the 95% confidence interval). All analyses were performed using SPSS v. 22.0 (IBM SPSS Statistics Version 22.0., IBM Corp., Armonk, New York, USA).

Results

Of 206 patients included in this study, 73.3% (n=151) were male and 26.7% (n=55) were female. The average age of the study group was 38.5±18.99 (age range 3-90, median 32). In the study group there is a 3-year-old child, while the rest were patients aged 16 and over. The average age of women (40.5±19.11; age range 17-90, median 38) was higher than that of men (37.7±18.96; age range 3-87 and median 30), but not statistically important (p=0.373). Also, all patients were HIV negative.

AFB smear results of the patients; 49 (23.8%) were found as ++++, 140 (68%) were found as +++, 10 (4.9%) were found as ++, and 7 (3.4%) were found as +. There was no correlation

(r_s=0.11632, p=0.096) between the increase in the degree of AFB positivity and number of radiological lesion types (presented in Table 1).

The most common radiological finding in the patients was nodular opacities with a rate of 76.2%, followed by the presence of patchy infiltrate seen in 128 (62.1%) of the patients. The frequency of both findings did not differ according to gender or imaging method.

The presence of cavitation was detected in 95 (46.1%) of the patients. The cavitation rate was found to be 84.3% in CT images and 33.5% in X-ray, the difference was significant (p<0.001). Although cavitation was present in more than one region in some patients, the presence of cavitation was most frequently associated with the upper lung lobes. Of the 95 patients with cavitation, 78.9% (n=75; 29 right upper, 28 left upper and 18 bilateral upper) had cavitation in the upper lung lobes.

Consolidation was detected in 93 (45.1%) of the patients. The consolidation rate was found to be 60.8% in CT images and 40.0% in X-ray (p=0.010). Similarly, bronchiectasis and miliary involvement rates were also detected at significantly higher rates in CT imaging than X-ray (p<0.001).

Lymphadenopathy (21.4%) and scar (20.4%) were other common findings, and their frequency did not differ according to gender or imaging method.

When 31 (15%) patients with pleural effusion were examined, it was determined that pleural effusion was seen at a significantly higher rate in women, unlike other radiological findings (p=0.012).

The distribution of the findings in Table 1 were examined covering all patients, 26 patients had a single lesion type. Consolidation was the only radiological finding in 14 of the patients (6.8%). Similarly, as the only radiological findings in four patients was nodular opacities, in three patients was pleural effusion, in three patients was cavity, in one patient was miliary involvement, and in one patient was scar.

There were 2 different lesion types in 41 patients, 3 different types in 60 patients, 4 different types in 51 patients, 5 different types in 21 patients, 6 different types in 5 patients, and 7 different types in 2 patients (of the 10 different lesion types presented in Table 1).

Six patients had lesions (nodular opacities and/or patchy infiltrate and/or consolidation) affecting the entire lung, unilaterally or bilaterally. These lesions completely involved the right lung in two patients, the left lung in two patients, and both lungs in two patients.

Table 1. Frequency and distribution of radiological presentations in pulmonary tuberculosis patients.

	X-ray (n=155)				CT (n=51)				All patients (n=206)			
	male		female		male		female		yes	no	p	
	yes	no	yes	no	yes	no	yes	no	n (%)	n	X-ray / CT	male / female
Nodular opacities	88	28	29	10	27	8	13	3	157 (76.2)	49	0.671	1.000
Patchy infiltrate	69	47	23	16	25	10	11	5	128 (62.1)	78	0.151	1.000
Cavitation	40	76	12	27	29	6	14	2	95 (46.1)	111	**<0.001** (CT)	0.841
Consolidation	44	72	18	21	21	14	10	6	93 (45.1)	113	**0.010** (CT)	0.315
Lymphadenopathy	29	87	8	31	6	29	1	15	44 (21.4)	162	0.125	0.292
Scar	21	95	7	32	12	23	2	14	42 (20.4)	164	0.149	0.386
Pleural effusion	11	105	8	31	6	29	6	10	31 (15.0)	175	0.051	**0.012** (female)
Bronchiectasis	4	112	2	37	13	22	2	14	21 (10.2)	185	**<0.001** (CT)	0.403
Tuberculoma	9	107	4	35	3	32	1	15	17 (8.3)	189	0.584	0.493
Miliary involvement	1	115	1	38	9	26	2	14	13 (6.3)	193	**<0.001** (CT)	0.526

Please note that the patients whose X-ray and CT imaging results are presented in the "Results" section are different patients and a direct comparison of the two methods is not presented.

Data regarding patients' clinical information was limited due to deficiencies in the registration system. According to accessible retrospective records cough, sputum, and chest pain were complaints reported by more than 80% of patients (Table 2). There was little patient information for fever, hemoptysis, dyspnea, sweating, and weakness.

While the majority of patients were newly diagnosed patients, 14.8% (23/155) of the patients with accessible data were patients with a history of TB. In the study group, 7.7% (12/143) of patients had diabetes and the significant majority of patients with diabetes were female (p=0.027). In diabetic patients, (n=12) nodular opacities and consolidation were 66.7% (n=8), cavitation rate was 58.3% (n=7) and patchy infiltrate was 50% (n=6). Consolidation and cavitation rates were higher in diabetic patients than in the non-diabetic patient group, but the difference was not significant (p=0.122 and p=0.380).

Four patients had intra-abdominal TB (lymphadenopathy, peritonitis, ascites, ileus), one patient had a vertebral lesion (abscess), and one patient had pericardial effusion.

Table 2. Frequency and distribution of symptoms in pulmonary tuberculosis patients.

									All patients (n=206)			
	Male (n=151)				Female (n=55)				yes		no	p
	yes	no	T	?**	yes	no	T	?**	n	%	n	male / female
Cough	114	14	128	23	45	5	50	5	159	89.3	19	0.862
Sputum	99	18	117	34	36	9	45	10	135	83.3	27	0.479
Chest pain	98	18	116	35	36	9	45	10	134	83.2	27	0.493
Other TB related signs*	17	26	43	108	7	10	17	38	24	40.0	36	0.920
Diabetes mellitus	5	105	110	41	7	38	45	10	12	7.7	143	**0.027** (female)
Previous TB history	15	95	110	41	8	37	45	10	23	14.8	132	0.512

*Fever, hemoptysis, dyspnea, sweating, weakness. **no information.

When the distribution of the lesions is examined, bilateral involvement is seen in 50.3% of the patients with X-ray results and in 70.6% of the patients with CT results (for any of the lesions in Table 1). There was no gender difference in X-ray or CT examinations for lesion distribution (Table 3 and Table 4). In X-ray examinations, the most frequent involvement was in the upper zones (81.3%), followed by the lower zone (38.7%) and middle zone (28.4%) (Table 3). In CT imaging, the regions with the most lesions were the upper lobes (78.4% and 74.5% on the right and left, respectively), followed by the basal zones and middle zones (Table 4).

Table 3. Localization and distribution of lesions identified on X-Ray imaging.

	Male (n=116)			Female (n=39)			All X-ray patients (n=155)			
	yes		no	yes		no	yes		no	p
	n	%	n	n	%	n	n	%	n	male / female
Right	84	72.4	32	29	74.4	10	113	72.9	42	0.806
Left	88	75.9	28	32	82.1	7	120	77.4	35	0.424
Upper	94	81.0	22	32	82.1	7	126	81.3	29	0.887
Middle	30	25.9	86	14	35.9	25	44	28.4	111	0.229
Lower	42	36.2	74	18	46.2	21	60	38.7	95	0.269
Bilateral involvement	56	48.3	60	22	56.4	17	78	50.3	77	0.380

Table 4. Localization and distribution of lesions identified on CT imaging.

	Male (n=35)			Female (n=16)			All CT patients (n=51)			
	yes		no	yes		no	yes		no	p
	n	%	n	n	%	n	n	%	n	male / female
Right - upper	28	80.0	7	12	75.0	4	40	78.4	11	0.475
Right - middle	11	31.4	24	7	43.8	9	18	35.3	33	0.393
Right - lower superior	22	62.9	13	9	56.3	7	31	60.8	20	0.655
Right - lower basal	10	28.6	25	3	18.8	13	13	25.5	38	0.352
At least one involvement on the right	29	82.9	6	15	93.8	1	44	86.3	7	0.282
Left - upper	28	80.0	7	10	62.5	6	38	74.5	13	0.162
Left - lingula	12	34.3	23	3	18.8	13	15	29.4	36	0.215
Left - lower superior	23	65.7	12	9	56.3	7	32	62.7	19	0.517
Left - lower basal	11	31.4	24	6	37.5	10	17	33.3	34	0.671
At least one involvement on the left	31	88.6	4	12	75.0	4	43	84.3	8	0.203
Bilateral involvement	25	71.4	10	11	68.8	5	36	70.6	15	0.547

Discussion

TB is an important public health problem worldwide, and in Somalia, especially among immunocompromised patients and other high-risk groups [13,15]. In a way that differentiates it positively from many other infectious diseases, for TB, there are diagnostic and treatment centers using new generation technology in Somalia, supported by the World Health Organization and run in coordination with the Federal and State Ministries of Health [9]. A comprehensive fight against TB continues with culture laboratories, molecular diagnostic tests (GeneXpert), probe hybridization tests to detect drug resistance, and centers that treat multidrug-resistant TB cases in many centers spread across the country [9].

TB continues to be a major global health problem affecting all countries and age groups around the world and radiology plays a very important role in the diagnosis and treatment of pulmonary TB [16]. Evaluations made with radiological imaging are used to classify the risk and evaluate asymptomatic active disease in TB patients [15]. In a 2003 study conducted in Gambia, it was reported that the most common radiological lesion seen on chest radiographs of newly diagnosed TB patients (n=340) was patchy infiltration (>90%) [17]. Although the majority of our study group consists of newly diagnosed patients, we cannot know exactly how many of these patients are new cases due to insufficient records, and although we cannot make an accurate comparison since most patients are diagnosed late, in our study group, the most common lesions were nodular opacities (76.2%), patchy infiltrate (62.1%), cavitation (46.1%) and consolidation (45.1%).

Our study group consists of HIV negative patients. In a study including CT findings seen in 30 HIV negative patients, the rates of nodular opacities, consolidation, cavitation and miliary TB were found to be 90.0%, 73.3%, 60.0% and 3.3%, respectively [18]. In our study, these rates were found to be 76.2%, 45.1%, 46.1% and 6.3% according to X-ray and CT evaluations. When only CT results were considered, these rates were 78.4%, 60.8%, 84.3%, and 21.6% (Table 1). This difference may be related to the fact that CT is clearly more sensitive than X-ray in detecting lung pathology [19], and it may also be related to the fact that patients for whom CT is preferred as a diagnostic imaging method have more severe clinical conditions. Hematogenous spread causes miliary TB, especially in immunocompromised and pediatric patients [15]. Since there were no HIV-infected patients in our study group and it generally included adults, the rate of miliary TB was low, consistent with the literature.

In *M. tuberculosis* infections, cavitation in the lung is a situation that provides an advantage for the spread of the organism. The resulting cavitation areas contain a large number of organisms and the abundant bacteria in aerosols can be transferred to other susceptible hosts. [19]. In the study conducted in Gambia, among newly diagnosed TB patients (n=340), 206 patients (60.6%) had cavitation, which occurs most frequently in the upper lung areas [17]. In our study, the presence of cavitation was detected in nearly half of the patients (46.1%, n=95; 33.5% in the X-ray group and 84.3% in the CT group; p<0.001), while, consistent with the literature, 78.9% (75/95) of the patients in whom cavitation was detected had cavitation in the upper lobes.

In postprimary TB, consolidation and cavitation have a strong predilection for the apical and posterior parts of the upper lobes as well as the upper parts of the lower lobes [15]. The data in Table 3 and Table 4, which we created to obtain an overview of the distribution of all lesions likely to be related to TB, including consolidation and cavitation, seem to be compatible with the literature information.

Pleural effusions are usually not a direct result of pleural infection by *M. tuberculosis* and rather result from hypersensitivity to tuberculin protein [15]. Pleural effusion in HIV-negative patients was found to be 16.7% in a study [18], and the rate was very similar in our study, 15.0%. From another perspective, pleural effusion is also seen in approximately 25% of primary TB cases and, less commonly, in approximately 18% of cases in postprimary disease [15]. The results of our study group, which included mainly adult patients and cases with advanced disease, were more similar to the second mentioned group.

Lymphadenopathy is seen in 83-96% of pediatric primary TB cases and 10-43% of adult cases and typically involves the right paratracheal and hilar lymph nodes [15]. The rates of lymphadenopathy in HIV-negative patients was found to be 23.3% in a previous study [18]. Our study consisted of patients aged 16 and over, except for a child (without lymphadenopathy). In our study, pulmonary lymphadenopathy rate was found as 21.4%.

Tuberculoma represents a pulmonary nodule and may be the only abnormality seen on chest radiographs in approximately 5% of patients with active TB [20]. In our study, tuberculoma was observed in 17 patients (8.3%), while all patients had at least one other accompanying lesion. We think that this is due to the fact that most patients included our study have advanced and untreated TB cases.

Clinical symptoms of active TB vary from a simple cough to irreversible lung damage due to disease progression, and the disease can result in death. Symptoms of TB may include prolonged cough with mucus, pleuritic chest pain, hemoptysis, dyspnea, wheezing, weakness or progressive fatigue, cachexia/weight loss, fever, night sweats, and malaise [21]. In our study group, more than 80% of patients had cough, sputum, and chest pain. In addition to its clinical presentation, TB has also been associated with some other systemic complications, such as hyponatremia and glucose intolerance [21]. Diabetes and active TB exacerbate each other, and the combination of these two diseases creates a lethal combination. Diabetic patients have many cavitation lesions compared to non-diabetic patients [18]. In our study, consolidation and cavitation rates were higher in diabetic patients than in the non-diabetic patient group, but the difference was not significant (p=0.122 and p=0.380).

The most important limitations of the study were that not every patient had X-ray and CT data and some patients had incomplete clinical information. Although the fact that our study group consisted only of HIV-uninfected patients made it easier to make comparisons with literature information, we can say that primary and postprimary infections cannot be completely distinguished from each other.

Conclusion

Although TB is a treatable and preventable disease, there are some problems about diagnosis and treatment. These include individual problems during the treatment process (mainly problems related to compliance with treatment and economic conditions) and general problems such as the fact that accessible health services have not yet reached all regions of the country.

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