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Radiological Assessment Of Lateral Chest Wall Soft Tissue Thickness In Pulmonary Tuberculosis

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ABSTRACT

Rationale: Weight loss is one of the many symptoms of pulmonary tuberculosis. It can also be found in other wasting diseases like malnutrition, malignancies and HIV infection and AIDS. As a result of this, it is expected that there will be a reduction in the soft tissue thickness of the lateral chest wall in patients with pulmonary tuberculosis and subsequent increase, when treatment has been adequately effected.

Objective: The purpose of this study is to find out if there is any definite reduction in the soft tissue thickness of patients with pulmonary tuberculosis when compared with healthy controls.

Methods: This is a prospective study in which the lateral chest wall soft tissue thickness on chest radiographs of 203 patients (children & adults) with bacteriologically and radiologically proven pulmonary tuberculosis, and nine months post-treatment asymptomatic and bacteriologically negative cases were measured. These were compared with a control group of 50 well-nourished patients, age and sex-matched and who had no clinical and radiological features of pulmonary tuberculosis.

Results: The total mean values of the subcutaneous fat and muscle layer thickness of the pre-treatment tuberculosis cases were 6.89 ± 2.6mm and 8.13 ± 2.85mm respectively. The mean values of the subcutaneous fat layer were observed to be significantly lower than the muscle layer in all the age groups ($P<0.05$). The mean subcutaneous fat and muscle layer thickness of the post-treatment cases were 14.47±6.09mm and 10.73±3.36mm respectively. A significant ($P<0.05$) increase in thickness was observed in the subcutaneous fat layer over that of the muscle layer in the post-treatment phase.

The total mean values of subcutaneous fat and muscle layer thickness in the control group were found to be 16.4 ± 5.6mm and 9.8± 2.9mm respectively. The fat layer recorded higher values than the muscle layer. In all, the total mean soft tissue thickness (14.7±5.2)mm in the pre-treatment tuberculosis patients was significantly ($P<0.05$) lower than in the post treatment (25.2±8.55)mm and control (26.2 ±7.6mm) .

Conclusions: The clinical implication of this study is that the total soft tissue thickness of the lateral chest wall can be used as an index for monitoring recovery in patients with pulmonary tuberculosis during treatment

Keywords: Pulmonary Tuberculosis, Subcutaneous fat, Muscle layer, Malnutrition

INTRODUCTION

Tuberculosis (TB) has contributed substantially to morbidity and mortality in virtually all age groups. It is a chronic infectious disease caused by a group of closely related species, forming mycobacterium tuberculosis complex[1].

However, tuberculosis has continued its 'scourge' prompting the World Health Organization (WHO) in 1993 to declare tuberculosis as a global emergency, with almost 2 billion people (one-third of the world population) estimated to be infected with M. tuberculosis[2]

Although there is a dearth of meaningful data for tuberculosis in most developing countries in the world, available records have shown that about 25,000 cases are being reported annually in Nigeria[3].

Weight loss is one of the many symptoms of pulmonary tuberculosis. It can also be found in other wasting diseases like malnutrition, malignancies and HIV infection and AIDS. Therefore, it is expected that there will be a reduction in the soft tissue thickness of the lateral chest wall in patients with pulmonary tuberculosis and other wasting diseases.

However, increase in body weight when the treatment has been effective has been reported [3]. It is to be expected that there will be an increase in the soft tissue thickness of the lateral chest wall in patients with pulmonary tuberculosis, who have received effective treatment and are responding positively to treatment.

The purpose of this study is to find out if there is any definite reduction in the soft tissue thickness of patients with pulmonary tuberculosis when compared with healthy controls. The other purpose of this study is also to establish a range nomogram of soft-tissue thickness in this environment.

MATERIALS AND METHODS

The materials consist of chest radiographs of 203 patients (children & adults) with bacteriological and radiological proven pulmonary tuberculosis. The chest radiographs of 50 well-nourished patients, age and sex-matched and who had no radiological features of pulmonary tuberculosis were used as control.

The post treatment cases were asymptomatic, bacteriologically negative and showed no active foci of tuberculosis on chest radiograph. The exclusion criteria for the control group included obesity, malnourished state and wasting disease like poliomyelitis.

All chest radiographs were taken in the erect posterior anterior position at an anode film distance of 2 meters.

In assessing each radiograph, the following measurements were made at the lateral chest wall:

1. The skin and subcutaneous fat layer (A mm) The skin layer which is represented by an ill-defined linear shadow is ignored in order to avoid confusion with histological definition of skin.
2. The muscle layer (B mm).
3. The total soft-tissue thickness (A+B mm)

Fig 1 is the sketch of the lateral chest radiograph showing the site of measurement that coincides with the junction zone termed the "No- mans -land" between the thorax and abdomen, described by Lagundoye and Reddy in chest radiographs of children with kwashiorkor[4]. This is an area in which the soft tissue runs parallel to the lower ribs about the level where the 9th and 10th ribs make their final curvature forwards from the mid- axillary line. Fig 2 is a representative chest radiograph of a pre-treatment case of tuberculosis with reduced soft tissue thickness. The average of the measures of the two sides was recorded in mm, while a test of significance was taken at $P<0.05$.

The data was keyed into the computer and the SPSS package was used for the analysis of the data.

RESULTS ANALYSIS

The age range of the 203 subjects in the study was 1-70 years, with a mean age of 29. 697± 15.42yrs. The total number of male patients was 93 to 110 females. Table I shows the age distribution pattern of all the subjects and the control in the study. Majority of the subjects 149 (74%) with pulmonary tuberculosis were in the older children and young adults within ages 11-40 years.

Tables II A shows the subcutaneous fat (A) and muscle (B) layers thickness including the Total Soft Tissue thickness (A+B) in the pre-treatment tuberculosis cases, while Table IIB shows measurements of the post-treatment cases of the disease. The pre treatment tuberculosis shows a total mean of 6.89 ± 2.6mm and 8.13 ± 2.85mm for the subcutaneous fat and muscle layers thickness respectively, across the age groups. The mean values of the subcutaneous fat layer were observed to be significantly lower than the muscle layer in all the age groups ($P<0.05$).

The post-treatment tuberculosis showed a total mean of 14.47±6.09mm and 10.73±3.36mm of the subcutaneous fat and muscle layers thickness respectively, indicating a significant ($P<0.05$) increase in thickness in the subcutaneous fat layer over that of the muscle layer in the post-treatment phase.

The observed measures shows a significant increase in the subcutaneous fat layer over that of the muscle layer thickness of the tuberculosis patients after treatment, whereas in the pre-treatment tuberculosis value , reduction in the thickness is more pronounced in the subcutaneous fat layer compared to the muscle layer .

Table III shows the mean subcutaneous fat layer thickness in the control group, it ranged from 8.28 ±1.6mm-21.3±4 .76mm while the muscle layer thickness ranged from 5.7± 1.49mm - 12.0± 4.08mm, with the total mean of 16.4 ± 5.6mm and 9.8± 2.9mm respectively. The fat layer recorded higher values than the muscle layer.

The total mean soft tissue thickness (14.7±5.2)mm in the pre-treatment tuberculosis patients was lower than the post treatment (25.2±8.55)mm and the control
(26.2 ±7.6mm). The difference was statistically

significant (P <0.05), hence adequate weight gain was achieved post-treatment. The difference observed in the mean soft tissue thickness in the post- treatment (25.8± 8.5mm) and the control group (26.28 ± 7.6mm) was not statistically significant.

Table IV shows the sex distribution pattern of the mean soft-tissue thickness in the pre-treatment, post-treatment and control groups, The males recorded a lower soft tissue thickness (14.3± 5.8mm) than the females (15.08± 4.6mm) in the pulmonary tuberculosis patients prior to treatment. Similar lower soft tissue thickness values were recorded in the males in the post-treatment (23.9 ± 7.9mm) and the control (25.4± 6.9mm) than the females in the post-treatment (26.28± 8.9mm) and control (27.1±8.5mm). These mean differences were however not statistically significant.

DISCUSSION:

Tuberculosis remains the major cause of death from a single infectious agent amongst adults in developing nations, with high morbidity and mortality. The risk of infection is higher in countries where the standard of living is low and health resources are scarce, and 80% of infected patients are in their productive years between 15-59 years of age. This study recorded higher cases of patients with pulmonary tuberculosis between 11-40 years of age. Weight loss is one of the common symptoms of pulmonary tuberculosis, and it can also be found in HIV infection, AIDS, malnutrition and malignancies[5]. In HIV and other related debilitating diseases there is definite weight loss or wasting which is due to break down of muscle and subcutaneous fat[6]. A similar trend was noticed in this study where patients with pulmonary tuberculosis showed weight loss as evidenced by reduction in both their mean subcutaneous fat and muscle layer values before treatment.

Various methods have been used to estimate soft tissue wasting, they include anthropometry, skin fold measurement and ultrasound[7,8] . Other methods include MRI and CT[9,10] . DEXA is a relatively new technology that may also be used to evaluate body composition[11]. This study utilized a similar method performed by Lagundoye et al[4] in pediatric patients with kwashiorkor, but this time with a different pathology, which was pulmonary tuberculosis but also a "Wasting" disease similar to kwashiorkor. The patients included both pediatric and adult age-groups.

Lagundoye et al[12] showed a definite reduction in both subcutaneous fat and muscle layer in the affected children prior to treatment, with the reduction in subcutaneous fat layer which out-paced that of the muscle layer. It also revealed that children with kwashiorkor showed an increase in both subcutaneous fat and muscle layers post- treatment, with the value of the subcutaneous fat layer significantly higher than that of the muscle layer after treatment. Similar pattern of variation in subcutaneous fat and muscle layer thickness was observed in this present study of pulmonary tuberculosis at both pre and post-treatment. In all the age groupings in this study, positive response to treatment was noticed, as the differences in the pre and post treatment mean values of the subcutaneous fat and muscle layer thickness were statistically significant, and in favour of the post-treatment mean value.

Pulmonary tuberculosis infection can be rapidly progressive and fatal, and reaches its maximum peak in women between 20-25 years of age, and in men between 40-50 years of age. This study did not record significant sex difference in the soft tissue thickness in patients with pulmonary tuberculosis before and after treatment, and also in the healthy cases, although lower figures were recorded in all the groups amongst the males.

CONCLUSION:

The total soft tissue thickness (subcutaneous fat and muscle layers) is generally reduced in pulmonary tuberculosis, with the subcutaneous fat layer affected being much more affected than the muscle layer, but which subsequently showed an increase after treatment involving both layers. This study also showed that in normal healthy subjects, the thickness of the subcutaneous fat layer is higher than that of the muscle layer in all age groups.

Table I: Age Distribution pattern of Tuberculosis Patients and Control

Age	TUBERCULOSIS PATIENTS			Control		
	Male N=93	Female N=110	Total N=203	Male N=25	Female N=25	Total N=50
0-10	11	8	19 (9.4%)	4	3	7 (14%)
11-20	15	31	46 (22.7%)	5	5	10 (20%)
21-30	26	28	54 (26.6%)	2	3	5 (10%)
31-40	23	26	49 (24.1%)	2	4	6 (12%)
41-50	6	8	14 (6.9%)	4	1	5 (10%)
51-60	4	4	8 (3.9%)	2	2	4 (8%)
61-70	8	5	13 (6.4%)	6	7	13 (26%)

Table IIA: Subcutaneous Fat and Muscle layer Thickness in Pre-Treatment Tuberculosis

	PRE-TREATMENT		
Age (years)	**Subcutaneous fat layer (mm) (mean ± SD)**	**Muscle layer (mm) (mean ± SD)**	**Total soft tissue (mm) (mean ± SD)**
0-10	4.158 ± 2.007	5.368 ± 2.671	9.526 ± 4.526
11-20	6.087 ± 2.074	7.522 ± 2.074	13.609 ± 3.924
21-30	6.870 ± 2.356	8.056 ± 2.302	14.926 ± 4.321
31-40	7.612 ± 3.108	9.408 ± 3.523	17.020 ± 6.411
41-50	6.286 ± 2.301	8.500 ± 2.710	14.786 ± 4.775
51-60	7.500 ± 1.773	9.000 ± 1.604	16.500 ± 3.295
61-70	6.692 ± 2.428	9.000 ± 2.415	15.692 ± 4.608
TOTAL	6.59 ± 2.6	8.13 ± 2.85	14.72± 5.22

Table IIB: Subcutaneous Fat and Muscle layer Thickness in Post-Treatment Tuberculosis

	POST – TREATMENT		
Age (years)	**Subcutaneous fat layer (mm) (mean ± SD)**	**Muscle layer (mm) (mean ± SD)**	**Total soft tissue (mm) (mean ± SD)**
0-10	8.632 ± 2.773	6.316 ± 2.668	14.947 ± 4.938
11-20	14.500 ± 9.208	9.978 ± 2.380	24.478 ± 10.340
21-30	14.019 ± 4.182	10.648 ± 2.714	24.667 ± 6.495
31-40	15.388 ± 4.391	12.327 ± 3.654	27.714 ± 7.711
41-50	16.786 ± 4.917	12.286 ± 3.049	29.071 ± 7.395
51-60	18.625 ± 4.897	11.125 ± 3.227	29.750 ± 6.861
61-70	16.308 ± 4.590	12.385 ± 2.631	28.692 ± 6.613
TOTAL	14.47± 6.09	10.73± 3.36	25.2± 8.55

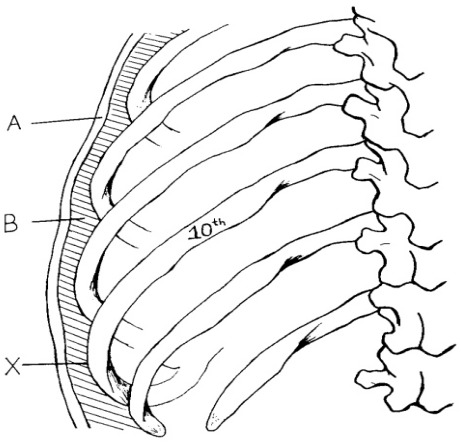
Table III: Subcutaneous fat and Muscle layer Thickness in Control

Age (years)	Subcutaneous fat layer(mm) (mean ± SD)	Muscle layer(mm) (mean ± SD)	Total soft Tissue (mm) (mean ± SD)
0-10	8.286 ± 1.604	5.714 ± 1.496	14.00 ± 1.732
11-20	15.800 ± 3.360	9.500 ± 2.014	25.300 ± 4.809
21-30	14.600 ± 2.881	9.800 ± 3.347	24.400 ± 2.881
31-40	21.333 ± 4.761	10.167 ± 2.317	31.500 ± 6.091
41-50	21.000 ± 4.528	11.200 ± 1.095	32.200 ± 3.962
51-60	17.750 ± 4.193	12.000 ± 4.082	29.750 ± 8.221
61-70	17.769 ± 5.600	10.846 ± 2.577	28.615 ± 7.240
Total	16.48± 5.6	9.8± 2.92	26.28± 7.6

Table IV: Sex distribution pattern of total mean Soft Tissue Thickness in Pre and Post Treatment phases of Tuberculos Patients and Control

SEX	PRE-TREATMENT TB	POST – TREATMENT TB	CONTROLS
M	14.3± 5.8mm	23.9 ± 7.9mm	25.4± 6.7mm
F	15.08 ± 4.6mm	26.28± 8.9mm	27.1 ± 8.5mm

Fig 1: Sketch showing two component Layers (A, B) making up the total Soft Tissue Thickness (A+B) of the Lateral Chest Wall in Routine Chest X-Ray in Healthy Individual.



Key:
A = Skin & Subcutaneous Fatty Layer
B = Muscle Layer

X = Point of Measurement [No Mans land]

Fig 2: Anterio-Posterior Chest Radiograph of a patient with Tuberculosis with reduced Soft Tissue Thickness (arrow)

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