

ORIGINAL ARTICLE

Sensitivity and specificity of the inner thigh, as a site for Mantoux test

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ABSTRACT

Background: Early diagnosis, prompt treatment and case finding are vital measures in the management of Tuberculosis (TB), a common infectious disease with a worldwide spread. Mantoux test, a type IV hypersensitivity reaction, is commonly used to screen children for possible TB. It is applied on the volar aspect of the forearm. The estimated sensitivity of Mantoux test on patients with TB disease ranged from 80% to 96%. The test is affected negatively by severe malnutrition and immunosuppression. Sunlight ultraviolet rays (UV) have recently been shown to induce immunosuppression that alters the skin response to Mantoux test negatively.

Objective: To investigate the adequacy of the inner thigh as a site for Mantoux test.

Methods: Concomitant intradermal injection of 0.1ml of purified protein derivative (PPD) on the forearm and the inner thigh was carried out; and induration measured simultaneously in 106 consecutive children, aged 3months to 15 years. The forearm was used as standard to test for sensitivity and specificity of the inner thigh.

Results: Of the 29 subjects with reactive induration, 19(66%) were positive inner thigh and 10(35%) on the volar surface. Inner thigh measurement had a sensitivity of 100% and specificity of 88.5%. The positive and negative predictive values of the inner thigh measurements was 65.5% and 100% respectively while the efficiency was 91%.

Conclusions: The specificity and sensitivity of the inner thigh as a site for the screening and early detection of TB appears strong, it should be considered as a possible site for Mantoux test.

Keywords: Adequacy, children, efficiency, predictive values

INTRODUCTION

Tuberculosis (TB) is an infectious disease caused by the bacterium of the genus *Mycobacterium*. It is a disease of public health concern. Tuberculosis is an age-long disease and is believed to be present before the beginning of recorded history and has left its mark on human creativity, music, art, and literature.¹ Pulmonary TB is transmitted from person to person, usually by mucous droplets that become airborne when the infected

individual coughs, talks or spits.² This is usually an adult with cavitary pulmonary disease, although older children may also contribute to transmission.^{3,4} In much of sub-Saharan Africa where the concurrent HIV epidemic is speeding the TB epidemic and the number of adult TB cases is rapidly increasing. The rates of TB in children are unknown.

The annual morbidity /mortality rate is high, and the WHO case notification rates for TB shows that Sub-Saharan Africa contributed 30% of the global incidence of TB cases; with the highest numbers of case notifications occurring in Nigeria and South Africa.⁵

Timely detection of the infection, accurate diagnosis, prompt treatment with readily available anti-tuberculosis drugs and supportive treatment are important measures for survival given the mortality indices. However, early clinical presentations can be vague and may mimic some common illness, and therefore, early diagnosis depends on high index of suspicion confirmed by investigative procedures. The importance of early intervention in TB treatment underscores the need for accurate and affordable screening test methods.

Diagnostic difficulties pose the greatest challenge to childhood TB management.⁶ Traditionally, the diagnosis of TB in childhood is based on clinical criteria, such as persistent wheezing or cough, chest radiography, history of close household contact with an adult with pulmonary TB and tuberculin skin testing.⁷

Mantoux test, a type IV hypersensitivity reaction, is commonly used to screen children for possible TB infection particularly in the less developed countries. The test is read after 48-72hours of administering the purified protein derivative (PPDS) antigen on the volar surface of the forearm.

The ideal screening test should correctly identify all patients with the disease, and those patients who are disease-free. In other words, a perfect test is never positive in a patient who is disease-free and is never negative in a patient who is infected. It means that the sensitivity (the capacity of the test to correctly discover those patients with the disease), and specificity (ability of the test to appropriately identify patients without the disease) would be 100%. The estimated sensitivity of currently available tuberculin skin tests (TSTs) is based on the use of these

tests in patients with TB disease and ranges from 80% to 96%.⁸

Approximately 10% of immunocompetent children with TB disease have a negative TST.^{9,10} These variable results is further compounded by the drawbacks to the use of Mantoux test which may be affected by certain factors. These include severe malnutrition, and steroid and / or cytotoxic therapy.^{11,12} Ultraviolet rays (UVR) induced immunosuppression has in recent times been shown to alter the skin response to the Mantoux test negatively.^{13,14,15,16,17}

Several sites have been suggested as newer and safer alternatives to the traditional volar surface of the forearm. Kuchel and Barnetson suggested the use of the lower back as site for Mantoux testing, especially in tropical countries where the population is exposed to large amounts of sunlight.¹⁶

Previous studies done in different settings have shown that Mantoux induration measurements were higher in sites not exposed to UV rays.^{16,18} However, there is a dearth of materials on the determination of the adequacy of these alternate sites for Mantoux.

This work sought to investigate the adequacy of the inner thigh as a site for Mantoux test.

METHODOLOGY

This prospective cross-sectional study was conducted over a 5-month period at the Federal Medical Centre Owerri (FMCO), Nigeria. One hundred and six children, whose primary attending physicians requested a Mantoux test, were studied. They were, consecutively, enrolled and their age ranged from 3months to 15years.

Ethical approval was obtained from FMCO Ethics Committee. Informed consent was obtained from the parents/care givers of the children before enrolment. Any subject on cytotoxic and /or steroid therapy within 6weeks before enrolment was excluded. Using a structured interviewer administered

questionnaire, relevant socio-demographic and clinical information were obtained.

A solution containing 5 tuberculin units of PPD, reconstituted shortly before use, was concomitantly injected using a 27Gauge needle, intradermally, at a dose of 0.1ml. It was administered on the volar aspect of the forearm and on the inner thigh (one finger breath medial to the spatial line running down the middle of the thigh); by the principal investigator after training on and standardization of the procedure with an assistant. Standard aseptic protocols were observed throughout data collection. The injection site was demarcated with an indelible ink marker, in a circle, with the site of the injection situated in the middle of the mark. The parents /caregivers and / or subjects were advised not to scuff the site or sponge it during a bath, and to put on clothes on the children that will cover the thigh.

$$\text{Sensitivity: } \frac{\text{Number of true positives}}{\text{Number of true positives} + \text{Number of false negatives}} \times 100\%$$

$$\text{Specificity: } \frac{\text{Number of true negatives}}{\text{Number of false positives} + \text{Number of true negatives}} \times 100\%$$

$$\text{Positive predictive value: } \frac{\text{Number of true positives}}{\text{Number of true positives} + \text{Number of false positives}} \times 100\%$$

$$\text{Negative predictive value: } \frac{\text{Number of true negatives}}{\text{Number of false negatives} + \text{Number of true negatives}} \times 100\%$$

RESULTS

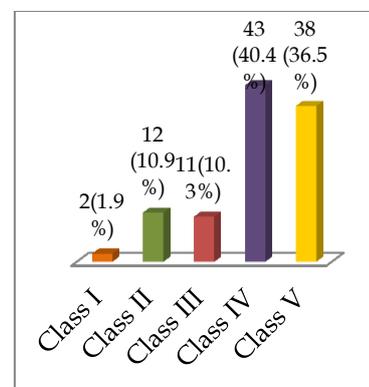
The age of the subjects ranged from 3months - 15years. Of the 106 children, 60 (56.6%) were male, while 46 (43.4%) were female. The male/female ratio was 1.3:1. The mean age at the time of recruitment was 6.5 ± 4.2 years.

Considering the social classification of the study population of 106 subjects, using the Oyedeji Classification, 2 (1.9%) belonged to social class I, 12 (10.9%) belonged to social class II, 11 (10.3%) belonged to social class III, 43 (40.4%) belonged to social Class IV and 38 (36.5%) belonged to social Class V.^{21,22} Figure 1 illustrates the social class distribution of the children.

After 48-72hours following the administration, the sites of the Mantoux test were examined. In children who had an induration, a measurement of ≥ 10 mm was considered positive. It was measured along the transverse axis of the forearm and thigh in millimeters with a plastic transparent metre rule.¹⁹ The ball point pen technique of Sokal was used.²⁰ Reading was done under a well illuminated room by one individual (Researcher, or Trained Assistant).¹²

Statistical analysis was done using the Statistical Package for Social Sciences (SPSS) for Windows (Inc. Chicago USA, 2001). Using Mantoux induration cut-off of 10mm as gold standard, the sensitivity, specificity, positive and negative predictive values of Mantoux induration measurements were calculated using the following formulae:

Figure 1. Social class distribution of the study population



Mantoux induration diameter of ≥ 10 mm was considered as cut-off for positivity. A total of 29 subjects were positive for tuberculosis

using the inner thigh while 19 were positive using the volar surface of forearm. There were 10 cases of negative volar surface reading but, positive on the inner thigh.

There were 19(17.9%) true positive subjects (positive for volar surface and inner thigh), 10 (9.4%) false positive (positive for inner thigh but negative for volar surface), 77 (72.6%) true negative (negative for volar surface and the inner thigh) and 0 (0%) false negative (negative for volar surface but positive for inner thigh). The results are shown in Table 1 below.

Table1. Sensitivity, specificity and predictive values at induration cut-off of 10mm

Inner thigh	Volar surface of forearm induration		Total
	Present	Absent	
Present	19 (TP)	10 (FP)	29
Absent	0 (FN)	77(TN)	77
Total	19	87	106

TP= True positives; FP= False positives

TN= True negatives; FN= False negatives

Sensitivity (TP/TP+FN)

$$= 19/19+0 \times 100 = 100\%$$

Positive predictive value (TP/TP+FP)

$$= 19/19+10 \times 100 = 65.5\%$$

Specificity (TN/TN+FP)

$$= 77/77+10 \times 100 = 88.5\%$$

Negative predictive value (TN/TN+FN)

$$= 77/77+0 \times 100 = 100\%$$

DISCUSSION

In the present study, we used Mantoux induration cut-off of ≥ 10 mm to compute the sensitivity, specificity and predictive values of inner thigh induration measurements.

Only 27.4% of patients had positive induration on the inner thigh, when volar surface Mantoux induration measurement was ≥ 10 mm; thus, giving a sensitivity of 100%. This value is higher than the estimated sensitivity of currently available TSTs (administered on the volar surface of the forearm), based on the use of these tests in patients with TB disease; which ranges from 80% to 96%.⁸ The estimated sensitivity of currently available TSTs is based on the use of

these tests in patients with TB disease and ranges from 80% to 96%.⁸ The specificity of Mantoux test on the volar surface of forearm is approximately 10% in immunocompetent children with TB disease.^{9,10} However, specificity of the inner thigh was 88.5%.

The difference in the values is not unconnected with the fact that this study was conducted on subjects (children) with presumed TB infection. The administration of the test on a site (inner thigh), not exposed to UV rays could have improved our yield.

The sensitivity of 100% recorded in this study is high and the negative predictive value makes the inner thigh a likely efficient site for Mantoux administration and reading. This fact is, also, buttressed by the high value (91%) recorded for the overall efficiency of the site. The high negative predictive value and low positive predictive value obtained is quite commendable given that three out of every three patient that had a positive Mantoux induration could have TB infection. This is significant when interpreting Mantoux test result in children, where precision is essential for vital management decisions especially where facilities are scarce.

In view of the fact that a single undetected case, lost due to exposure to UV rays on administration of Mantoux on the volar surface can be catastrophic given the infection transmissibility, fatality rate and HIV pandemic; a test site with a high level of screening sensitivity and specificity is very essential. The need for early diagnosis and subsequent, treatment of patients with TB infection is imperative because of the high fatality rate when there is a co-infection with HIV.

It is instructive to note that the inner thigh assays documented a high number of false positive results in a TB endemic region. This is a pointer to the need to further evaluate the inner thigh when other factors that could affect Mantoux response are present. This could help to alleviate the drawback in the utilization of this site for Mantoux testing.

CONCLUSION

This study has demonstrated the possibility of the inner thigh being a superior site for Mantoux test compared to the traditional volar surface of the forearm, for the screening of children with suspected tuberculosis.

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