Section: Miscellaneous

Original Research Article

COMPARATIVE EVALUATION OF MYCOBACTERIA GROWTH INDICATOR TUBE (MGIT) AND LOWENSTEIN–JENSEN CULTURE FOR THE DIAGNOSIS OF PULMONARY TUBERCULOSIS IN CHILDREN

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ABSTRACT

Background: Pulmonary tuberculosis (PTB) in children is difficult to diagnose because of its paucibacillary nature and challenges in obtaining suitable respiratory specimens. The Mycobacteria Growth Indicator Tube (MGIT) system offers rapid culture-based detection and may improve early diagnosis. This study compared the diagnostic performance of MGIT with Lowenstein–Jensen (LJ) culture for diagnosing PTB in children. **Materials and Methods:** This descriptive study included 100 children aged <12 years with suspected PTB. Induced sputum or gastric lavage specimens were collected and processed using both MGIT and LJ culture methods. Diagnostic performance of MGIT was assessed using LJ culture as the reference standard. Sensitivity, specificity, positive predictive value (PPV), negative predictive value (NPV), and time to culture detection were evaluated. **Result:** MGIT detected Mycobacterium tuberculosis (MTB) in 5% of children compared with 6% by LJ culture, while non-tuberculous mycobacteria were isolated in 4% and 12% of samples, respectively. MGIT demonstrated a sensitivity of 83.33%, specificity of 100%, PPV of 100%, and NPV of 98.8% for MTB detection. The mean time to detection of MTB was markedly shorter with MGIT than LJ culture (13.6 vs. 51.3 days). Gastric lavage showed slightly higher MTB positivity than induced sputum (6.12% vs. 3.92%) using MGIT. **Conclusion:** MGIT demonstrated good diagnostic performance and substantially reduced the time required for detecting MTB compared with LJ culture. Its faster detection time may support earlier diagnosis and timely treatment of children with suspected PTB.

INTRODUCTION

Tuberculosis (TB) in children continues to be a major public health problem, particularly in countries such as India that carry a high burden of the disease. According to the World Health Organization (WHO), about 1.25 million children developed TB in 2022, resulting in approximately 214,000 deaths. More recent estimates for 2023 reported around 1.296 million new pediatric TB cases worldwide, with nearly 187,500 deaths among children younger than 14 years. India alone accounts for nearly 28% of the global burden of childhood TB.[1–3] Despite continuous efforts to control the disease, many children with TB remain undiagnosed because confirming the diagnosis is much more difficult in children than in adults.

Diagnosing Pulmonary tuberculosis (PTB) in children is challenging for several reasons. Young children, especially those below five years of age, are often unable to produce sputum for laboratory testing. In addition, childhood TB is usually paucibacillary, meaning that only a small number of bacteria are present in respiratory specimens.[4,5] Sputum smear microscopy, which is still widely used as an initial diagnostic test, has very low sensitivity and is reported to be positive in only about 0.6% to 3.6% of children with TB.4 This low detection rate often leads to delayed diagnosis and treatment, increasing the risk of disease progression and associated complications.

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Lowenstein–Jensen (LJ) culture has been widely used as the conventional culture method for confirming Mycobacterium tuberculosis (MTB). Although it is a reliable method for isolating the organism, its major limitation is the long time required to obtain results. A study from the Ethiopian National TB Reference Laboratory reported an average turnaround time of 31–36 days for LJ culture, while a study from Nigeria reported a mean detection time of approximately 30 days.[6-8] Such delays can postpone treatment initiation and affect clinical outcomes, particularly in children who require early diagnosis and prompt management.

The Mycobacteria Growth Indicator Tube (MGIT) system is an automated liquid culture method developed to enable faster detection of MTB. Compared with LJ culture, MGIT has been shown to reduce the time of detection to approximately 11–16 days in adult populations while also improving culture recovery rates.[6,8,9] In a pediatric study from Uganda involving 250 children with suspected PTB, the median time to detection was 6 days with MGIT compared with 49.5 days for LJ culture, highlighting the potential of MGIT to provide much earlier microbiological confirmation in children.[7]

Although several studies have compared MGIT with conventional culture methods, most have been conducted in adults or mixed-age populations.[8,10] Information on the diagnostic performance of MGIT specifically in children, particularly from Indian tertiary care hospitals, remains limited. Since children differ from adults in disease presentation, specimen collection, and bacterial load, findings from adult studies cannot always be directly applied to the pediatric population. Therefore, there is a need to evaluate the performance of MGIT in children using locally generated evidence.

The present study was undertaken to compare the diagnostic performance of the MGIT system and LJ culture for diagnosing PTB in children. The study aimed to evaluate whether MGIT could provide faster and more reliable microbiological diagnosis in children.

Aims and Objectives

Aim: To compare the efficacy of rapid culture test (MGIT) and AFB culture method for diagnosing tuberculosis in children.

Objectives

Primary Objective: To compare the diagnostic performance of MGIT and Lowenstein–Jensen (LJ) culture for the detection of MTB in children with suspected PTB.

Secondary Objectives

- To compare the time required for detection of MTB and non-tuberculous mycobacteria (NTM) by MGIT and LJ culture.
- To compare the culture yield of MGIT and LJ culture according to specimen type.

MATERIALS AND METHODS

This descriptive study was conducted in the General Medical Wards and Pediatric Outpatient Department of the Institute of Child Health and Hospital for Children, Chennai, over a period of 8 months.

Sample Size: A total of 100 children fulfilling the eligibility criteria were included in the study.

Study Population: Children aged <12 years attending the Pediatric Outpatient Department or admitted to the General Medical Wards with clinical suspicion of PTB were screened for eligibility.

Inclusion Criteria

Children aged <12 years were eligible for inclusion if they fulfilled one or more of the following criteria: presence of clinical features suggestive of TB, including cough, weight loss, unexplained fever, or unexplained lethargy; abnormal chest radiograph not responding to routine antibiotic therapy; a positive Mantoux test; history of contact with a patient diagnosed with TB; and willingness of the parent or guardian to provide written informed consent.

Exclusion Criteria

Children were excluded if they had identifiable causes other than TB for cough, weight loss, fever, or lethargy, were receiving anti-tubercular treatment at the time of enrollment, or were unconscious or seriously ill, making them unsuitable for participation in the study.

Data Collection: Eligible children underwent a detailed clinical evaluation using a structured proforma. Demographic details, presenting symptoms, past medical history, previous TB treatment, immunocompromised status, previous hospitalization, history of TB contact, passive smoking exposure, overcrowding, and socioeconomic status were recorded. Anthropometric measurements (height and weight), BCG scar status, and detailed general and systemic examinations were performed. Sociological assessment was also undertaken to evaluate domiciliary stability and anticipated adherence to study procedures.

Symptoms were defined using standardized criteria. Persistent cough was defined as a non-remitting cough lasting >2 weeks despite one course of antibiotics. Weight loss was defined as an unexplained reduction of >5% compared with the highest recorded weight during the preceding three months. Persistent unexplained fever was defined as fever >38°C lasting for more than one week without an identifiable cause. Persistent unexplained lethargy was defined as decreased activity or playfulness reported by the caregiver. A history of TB contact was defined as living with or near a person receiving treatment for TB or who had completed treatment within the previous two years.

Clinical Evaluation and Investigations: Children meeting the inclusion criteria underwent the following investigations:

- Chest radiography (anteroposterior view)
- Mantoux (tuberculin skin) test

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- Collection of induced sputum or gastric lavage samples for AFB smear microscopy, MGIT culture, and LJ culture.

Children aged >5 years were encouraged to provide induced sputum samples under the supervision of trained personnel, whereas gastric lavage specimens were collected from children aged <5 years by trained staff.

Chest Radiography: Chest radiographs were considered suggestive of TB when they demonstrated findings such as miliary shadows, hilar or paratracheal lymphadenopathy, with or without associated parenchymal lung involvement.

Mantoux Test: The Mantoux test was performed using 1 tuberculin unit (TU) purified protein derivative (PPD RT23 equivalent) administered intradermally. Induration was measured after 48–72 hours, and an induration of ≥10 mm was considered positive.

Induced Sputum Collection: Children were nebulized with 3% hypertonic saline for 10 minutes followed by chest physiotherapy. Respiratory secretions were collected using an appropriately sized nasogastric tube and transferred to sterile specimen containers.

Gastric Lavage Collection: Early morning gastric lavage was performed after overnight fasting of at least 6 hours using an appropriately sized nasogastric tube. Initial gastric aspirate followed by a saline wash was collected in sterile containers for microbiological analysis.

Laboratory Procedures

MGIT Culture: Clinical specimens were digested and decontaminated using the N-acetyl-L-cysteine–sodium hydroxide (NALC–NaOH) method. The processed sediment was resuspended in 1 mL of sterile phosphate-buffered saline (pH 6.8), and 0.5 mL was inoculated into MGIT vials according to the manufacturer's instructions. The inoculated tubes were incubated in the MGIT system until flagged positive or for a maximum incubation period of six weeks.

Lowenstein–Jensen (LJ) Culture: Following NALC–NaOH decontamination, the processed sediment was resuspended in sterile phosphate-buffered saline (pH 6.8), and 0.2 mL was inoculated onto Lowenstein–Jensen (LJ) medium slants. Cultures were examined daily during the first week and subsequently once weekly for up to 15 weeks. Both MGIT and LJ cultures were performed at the laboratory attached to the ICMR–National Institute for Research in Tuberculosis (NIRT), Chetpet, Chennai.

Outcome Measures: The primary outcome was the detection of MTB by MGIT and LJ culture. Secondary outcomes included the diagnostic performance of MGIT in terms of sensitivity, specificity, positive predictive value, and negative predictive value, comparison of time to culture positivity between MGIT and LJ culture, isolation of non-tuberculous mycobacteria, and culture positivity according to specimen type.

Statistical Analysis: Data were entered into Microsoft Excel and analyzed using SPSS version 25 (IBM Corp., Armonk, NY, USA). Categorical variables were summarized as frequencies and percentages, while continuous variables were expressed as minimum, maximum, and mean values. The diagnostic performance of the MGIT culture system was evaluated by calculating sensitivity, specificity, positive predictive value (PPV), and negative predictive value (NPV), using LJ culture as the reference standard. Associations between categorical variables were assessed using the Chi-square test or Fisher's exact test, as appropriate. A two-sided p-value <0.05 was considered statistically significant.

Ethical considerations: The study protocol was approved by the Institutional Ethics Committee, Madras Medical College, Chennai, India (IEC No: EC/NEW/INST/2011/0411). Written informed consent was obtained from the parents or legal guardians of all participating children before enrolment.

RESULTS

Among the 100 children included in the study, 54% were aged <5 years and 46% were >5 years. Males constituted 66% of the study population. Cough lasting >2 weeks was the most common symptom (87%), followed by fever (69%), weight loss (61%), and unexplained lethargy (42%). A history of TB contact was present in 29% of children. Mantoux positivity and abnormal chest X-ray findings were observed in 16% and 18% of cases, respectively. Specimens included induced sputum (51%) and gastric lavage (49%), while only 1% of children were sputum AFB smear-positive [Table 1].

Table 1: Demographic and Clinical Characteristics of Study Population

Variable	Category	N(%)
Age	< 5 years	54 (54%)
	> 5 years	46 (46%)
Gender	Male	66 (66%)
	Female	34 (34%)
Symptoms	Cough > 2 weeks	87 (87%)
	Fever	69 (69%)
	Weight loss	61 (61%)
	Unexplained lethargy	42 (42%)
Contact history	Present	29 (29%)
	Absent	71 (71%)

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Screening	Mantoux positive	16 (16%)
	Chest X-ray abnormal	18 (18%)
Specimen type	Induced sputum	51 (51%)
	Gastric lavage	49 (49%)
Sputum AFB smear	Positive	1 (1%)
	Negative	99 (99%)

MGIT detected MTB in 5% of samples, while LJ culture detected MTB in 6%. MTB-negative cultures accounted for 91% with MGIT and 82% with LJ. NTM were isolated in 4% by MGIT and 12% by LJ [Table 2].

Table 2: Comparison of MGIT and LJ Culture Results

Result	MGIT n (%)	LJ n (%)
MTB positive	5 (5%)	6 (6%)
MTB negative	91 (91%)	82 (82%)
NTM	4 (4%)	12 (12%)

MGIT demonstrated a sensitivity of 83.33%, specificity of 100%, PPV of 100%, and NPV of 98.8% for MTB detection. For NTM detection, MGIT showed a sensitivity of 100%, specificity of 33.3%, positive predictive value of 91.1%, and negative predictive value of 100% [Table 3].

Table 3: Diagnostic Performance of MGIT Compared with LJ

Diagnostic parameter	MTB detection	NTM detection
Sensitivity (%)	83.33	100
Specificity (%)	100	33.3
PPV (%)	100	91.1
NPV (%)	98.8	100
p-value	0.045*	—

For MTB-positive cultures, the mean time to detection was 13.6 days with MGIT compared with 51.3 days using LJ culture. Among culture-negative samples, the mean detection time was 38.95 days for MGIT and 83.07 days for LJ. For NTM-positive cultures, MGIT detected growth in a mean of 13.25 days, whereas LJ required a mean of 47 days [Table 4].

Table 4: Comparison of Time to Detection by MGIT and LJ

Result Category	Test	n	Minimum (days)	Maximum (days)	Mean (days)
MTB positive	MGIT	5	12	15	13.6
	LJ	6	28	98	51.3
MTB negative	MGIT	91	7	42	38.95
	LJ	82	56	104	83.07
NTM positive	MGIT	4	7	18	13.25
	LJ	12	14	70	47

Among gastric lavage specimens, MGIT and LJ cultures detected MTB in 3 (6.12%) and 4 (8.16%) cases. Among induced sputum specimens, both MGIT and LJ detected MTB in 2 (3.92%) cases [Table 5].

Table 5: Culture Positivity for MTB According to Specimen Type

Specimen Type	n	MGIT positive n (%)	LJ positive n (%)
Gastric lavage	49 (49%)	3 (6.12%)	4 (8.16%)
Induced sputum	51 (51%)	2 (3.92%)	2 (3.92%)

DISCUSSION

TB in children remains a major diagnostic challenge because of its paucibacillary nature and the difficulty in obtaining suitable respiratory specimens. Rapid and accurate microbiological diagnosis is essential for early treatment and improved clinical outcomes. The present study aimed to compare the diagnostic performance of MGIT culture with LJ culture for the detection of MTB in children.

In our study, the study population was predominantly composed of younger children with a male preponderance. Most participants presented with clinical features suggestive of PTB, while only a small proportion had sputum smear positivity. The two specimen types were almost equally represented. Similarly, Agrawal et al, in a cross-sectional study, reported a male predominance (60%), with most children belonging to the 5–10-year (30.7%) and >10-year (36%) age groups and a positive TB contact history in 21.3% of cases. They also identified fever (69.3%) and cough lasting >15 days (50.7%) as the most common presenting symptoms, with a similarly low rate of bacteriological confirmation.[11] Fenn et al. observed comparable diagnostic yields for gastric aspirate (8.7%) and induced sputum (7.2%), with no

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significant difference between the specimen types.[12] These findings indicate that common clinical presentation and diagnostic challenges of pediatric PTB, where microbiological confirmation is often limited because of the paucibacillary nature of the disease, emphasizing the need for multiple complementary diagnostic approaches.

The present study demonstrated that MGIT and LJ culture showed similar detection of MTB, while MGIT exhibited high diagnostic accuracy with excellent specificity and predictive values, supporting its utility in TB diagnosis. Similarly, Kumari et al., comparing LJ and BACTEC MGIT 960 in 80 suspected TB samples, reported that MGIT detected significantly more culture-positive cases than LJ (41/80 [51.25%] vs. 29/80 [36.25%]) and showed significantly shorter median time to detection (9 vs. 33 days).[13] Ssengooba et al., reported a higher sensitivity for MGIT than LJ culture (63.8% vs. 42.6%) using a composite microbiological reference standard.[14]

Jha et al., reported that smear microscopy showed a sensitivity of 38.12% and specificity of 100% using MGIT as the reference method, while MGIT detected MTB significantly faster than LJ culture.[15] These findings indicate that liquid culture systems such as MGIT provide reliable diagnostic performance and facilitate earlier microbiological confirmation of TB compared with conventional solid culture methods. Although MGIT detected one fewer MTB-positive case than LJ culture in the present study, its substantially shorter time to detection may facilitate earlier microbiological confirmation and treatment initiation.

Our findings showed that MGIT enabled earlier detection of MTB and NTM than LJ culture. Gastric lavage yielded slightly higher culture positivity than induced sputum, although both specimen types contributed to microbiological diagnosis. Kumari et al. also reported a significantly shorter median time to detection with MGIT 960 than with LJ medium.[13] Similarly, Venturini et al., reported that the sensitivity increased from 34% with a single gastric aspirate to 40.4% with two and 47.4% with three aspirates, highlighting the diagnostic value of gastric aspirate specimens.[16] Thangavelu et al., reported an overall NTM prevalence of 0.6%, with Mycobacterium intracellulare as the predominant species.[17] These findings support the usefulness of MGIT for earlier culture detection while emphasizing the complementary role of appropriate specimen selection in improving microbiological diagnosis of TB.

The findings of the present study suggest that MGIT is a reliable culture method for the diagnosis of children TB, offering high diagnostic accuracy and earlier detection than LJ culture. Although both culture methods showed comparable detection of MTB, the shorter turnaround time and satisfactory diagnostic performance of MGIT may facilitate earlier microbiological confirmation and clinical decision-making.

Limitations: This study was conducted at a single tertiary care centre with a relatively small sample size and a limited number of culture-confirmed TB cases, which may have affected the precision of the diagnostic performance estimates. Molecular methods were not used to resolve discordant culture results, and drug susceptibility testing was not performed. Culture-based diagnosis in children may underestimate disease because of the paucibacillary nature of pediatric TB.

CONCLUSION

The MGIT system is a reliable liquid culture method for diagnosing PTB in children. MGIT demonstrated good diagnostic accuracy and substantially reduced the time required for detecting MTB compared with LJ culture. Although MGIT detected one fewer MTB-positive case than LJ culture, its shorter turnaround time may facilitate earlier microbiological confirmation and timely initiation of treatment. Larger multicentre studies are warranted to validate these findings.

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