

Clinicopathological Correlation and Comparative Evaluation of Slit-Skin Smear Findings from Earlobes and Cutaneous Sites Across the Clinical Spectrum of Hansen's Disease

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Hansen's disease demonstrates a wide clinical and immunopathological spectrum, requiring correlation of clinical, bacteriological, and histopathological findings for accurate diagnosis and classification. This study evaluated clinicopathological correlation and compared slit-skin smear (SSS) positivity from bilateral earlobes and representative cutaneous lesions across the disease spectrum. This hospital-based observational study included 45 patients with Hansen's disease attending a tertiary care centre from August 2023 to July 2024. Patients were classified clinically using Indian Association of Leprologists (IAL) and WHO operational classifications. SSS was performed from bilateral earlobes and active lesional sites or infiltrated skin in diffuse disease. Histopathological examination of skin biopsies was used for confirmation and classification. Lepromatous leprosy (42.2%) was the most common subtype, followed by borderline lepromatous (31.1%) and borderline tuberculoid disease (20%). Grade 1 and 2 disabilities were more frequent in multibacillary disease with longer symptom duration. Earlobe SSS positivity increased toward the lepromatous pole, while lesional smears demonstrated higher bacillary yield. Histopathological discordance was observed mainly within the borderline spectrum. Several smear-negative BL and LL patients had already initiated multidrug therapy and also reported prior prolonged undocumented exposure to multiple antibiotics. Combined clinical, bacteriological, and histopathological assessment improves diagnostic accuracy and classification in Hansen's disease. Histopathology remains the gold standard, particularly in borderline disease, while SSS positivity varies with disease spectrum, sampling site, and prior treatment.

Keywords : Hansen's Disease, Slit-skin Smear, Bacteriological Index, Histopathology, Clinicopathological Correlation

Introduction

Accurate diagnosis and classification of Hansen's disease are essential for appropriate therapeutic decision making and prevention of long-term complications. Owing to the wide

clinical and immunopathological spectrum of the disease, clinical assessment alone may be insufficient for precise classification, particularly in borderline forms. Hence, laboratory based diagnostic modalities continue to play a critical

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adjunctive role. The diagnosis of leprosy is based on characteristic clinical features along with bacteriological and histopathological confirmation (Kumar & Dogra 2023). For operational purposes, the World Health Organization classifies the disease into paucibacillary and multibacillary forms based on lesion count, nerve involvement, and slit-skin smear findings, while the Ridley-Jopling classification reflects the underlying immunological and bacteriological spectrum (Mishra & Kumar 2023). Slit-skin smear examination, introduced in 1927, remains a simple and cost-effective technique for estimating bacillary load through the bacteriological index (BI) and assessing bacillary viability using the morphological index (MI) (Rajan & Ponnaiya 2023, Khurana 2021). Histopathological examination further facilitates accurate disease classification (Kakkad et al 2016).

Clinico-histopathological correlation is crucial for improving diagnostic accuracy and guiding optimal management of Hansen's disease. Although India continues to report a substantial number of new cases annually, including in states that have achieved elimination targets (World Health Organization 2024, Verma et al 2022), studies evaluating comprehensive clinicopathological correlation and usefulness of simple techniques like SSS across the entire disease spectrum remain limited in current scenario.

The present study was undertaken to assess clinico-pathological correlation in Hansen's disease, with particular emphasis on slit-skin smear findings from cutaneous lesions and bilateral earlobes, and their association with histopathological features.

Materials and methods

This hospital-based observational study was conducted in the Department of Dermatology, Venereology and Leprosy at Indira Gandhi Medical College from August 1, 2023 to July

31, 2024 after obtaining approval from the Institutional Ethics Committee. Written informed consent was obtained from all participants prior to enrolment.

A total of 45 patients with Hansen's disease were included in the study. Newly diagnosed patients as well as patients receiving multidrug therapy (MDT) who had not completed treatment were included. Patients who had completed MDT before the study period were excluded from the study.

Demographic details, duration of disease, history of lepra reactions, treatment history, and contact history were recorded. Detailed dermatological and neurological examination was performed in all patients. Clinical examination included documentation of number, type and distribution of skin lesions, lesion margins, presence of satellite lesions, sensory impairment, nerve enlargement, nerve tenderness, and deformities. The number and consistency of peripheral nerves involved were also recorded. Disabilities were graded as per WHO's criteria (Brandsma & van Brakel 2003).

For operational purposes, patients were classified according to WHO paucibacillary (PB) and multibacillary (MB) classification (WHO 2018). Clinical classification was according to the Indian Association of Leprologists (IAL) classification system (IAL 1982), including borderline tuberculoid (BT), mid-borderline (BB), borderline lepromatous (BL), lepromatous leprosy (LL), histoid Hansen's disease, and pure neuritic leprosy.

Slit-skin smears were obtained from bilateral earlobes and representative clinically active cutaneous sites wherever identifiable. In diffuse lepromatous disease without discrete lesions, smears were obtained from infiltrated skin sites. In patients with multiple lesions, representative

active lesions were selected for sampling. Smears were stained using Ziehl-Neelsen staining and examined under oil immersion microscopy. Bacteriological index (BI) was graded according to Ridley's logarithmic scale (0–6+). Morphological index (MI) was calculated as the percentage of uniformly solid-staining bacilli among 100 acid-fast bacilli examined (Khurana 2021).

In borderline cases, biopsy specimens were obtained from the active infiltrated margins of representative lesions, whereas in lepromatous leprosy (LL), where discrete lesions were absent, biopsies were taken from areas of diffuse skin infiltration. In the patient with borderline borderline (BB) Hansen's disease, the biopsy was specifically obtained from the outer infiltrated edge of the lesion. In pure neuritic Hansen's disease, biopsy was performed from the radial cutaneous nerve, while in histoid Hansen's disease, the specimen was obtained from a representative nodular lesion. Skin biopsy was done using a 5-mm punch biopsy extending into the deep dermis and subcutaneous tissue. Histopathological examination was considered the reference standard for confirmation and classification.

Data obtained were entered into Microsoft Excel and analysed descriptively using SPSS version 16.0.

Results

A total of 45 patients with Hansen's disease were included in this hospital-based study, comprising 33 males (73.3%) and 12 females

(26.7%), with a mean age of 41.4 ± 16.1 years. The majority of patients (18; 40%) belonged to the 31–50-year age group. Most participants were Indian nationals (24; 53.3%), of whom 11 (24.4%) resided within the hospital surveillance area and 13 (28.9%) belonged to areas outside the surveillance region. Patients residing within the hospital surveillance area were categorized as "inside project area" (IPA), whereas those residing beyond the designated surveillance catchment region were categorized as "outside project area" (OPA). The remaining participants were Nepalese nationals (21; 46.7%), reflecting the presence of Nepalese workers in the region and their direct utilization of healthcare services. These patients were not referred by doctors from Nepal, but are working in the region and presented directly for health care and patient inflow to the tertiary care centre.

Most patients were married 38 (84.4%) and belonged to lower socio-economic backgrounds 29 (64.5%). Nearly half of the patients 22 (48.9%) were uneducated, and labourers constituted the largest occupational group 21 (46.7%). Only 1 patient (2.2%) reported a family history of leprosy. Two-thirds cases i.e., 30 (66.7%) were newly diagnosed cases, while 15 (33.3%) were on treatment at the time of enrolment in the study.

Based on clinical diagnosis, lepromatous leprosy (LL) was the most common subtype, observed in 19 patients (42.2%), followed by borderline lepromatous (BL) leprosy in 14 patients (31.1%) and borderline tuberculoid (BT) leprosy in 9

Table 1: Clinical diagnosis of Hansen's disease cases included in the study (N = 45).

Clinical Diagnosis	BT	BB	BL	LL	Histoid	Pure Neuritic	Total
Number of patients	9	1	14	19	1	1	45
Percentage %	20	2.2	31.1	42.2	2.2	2.2	99.99

patients (20%). One case each (2.2%) of mid-borderline, histoid, and pure neuritic leprosy was identified clinically. No cases of tuberculoid leprosy were observed (Table 1).

The number of skin lesions ranged from few well to ill-defined localized lesions to multiple ill-defined diffuse lesions across the clinical spectrum. Borderline tuberculoid (BT) lesions presented as asymmetrically distributed hypopigmented or erythematous plaques with sloping borders and pseudopodia, with satellite lesions observed in some patients. The patient with borderline borderline (BB) leprosy showed three lesions with characteristic well-defined punched-out inner margins and ill-defined outer borders. Borderline lepromatous (BL) lesions comprised numerous asymmetric ill-defined hypopigmented to coppery macules, papules, and plaques with a tendency toward symmetrical distribution, whereas lepromatous leprosy (LL) demonstrated innumerable bilaterally symmetrical shiny erythematous or hypopigmented macules with diffuse infiltration. The histoid leprosy case was characterized by multiple well-defined, smooth, shiny papules

and nodules arising over apparently normal skin. Peripheral nerve enlargement was observed in 37 patients (82.2%), with ulnar nerve involvement being most common. Multiple nerve involvement was more frequent in BL and LL cases. Enlarged nerves showed variable consistency across the spectrum, ranging from firm and tender nerves in borderline disease to fibrosed cord-like nerves in long-standing multibacillary cases with disabilities. A single patient clinically diagnosed with pure neuritic Hansen's disease presented with enlargement of multiple peripheral nerves of firm consistency associated with sensory impairment, in the absence of any cutaneous lesions.

Using WHO disability grading, 11 patients (24.4%) had no disability (Grade 0), while 19 patients (42.2%) had Grade 1 disability and 15 patients (33.3%) had Grade 2 disability. Grade 1 and Grade 2 disabilities were predominantly observed in multibacillary disease, especially borderline lepromatous (BL), lepromatous leprosy (LL), and histoid Hansen's disease. Most Grade 2 disabilities were observed in patients with disease duration of more than one year,

Table 2: Distribution of different grades of disability among the study participants as per WHO criteria (n = 45).

Clinical Type	Grade 0	Grade 1	Grade 2	Duration in Grade 2 disability
BT (n=9)	6	3	0	
BB (n=1)	1	0	0	
BL (n=14)	3	7	4	>1 year
LL (n=19)	1	8	10	1-3 years
Histoid (n=1)	0	0	1	>2 years
Pure neuritic (n=1)	0	1	0	

Footnote: Grade 2 disabilities were predominantly observed in multibacillary disease (BL, LL, and Histoid Hansen's disease), particularly among patients with prolonged disease duration and delayed presentation. No ocular disabilities were recorded.

Table 3: Bacteriological index (BI) from ear lobe slit skin smears by clinical diagnosis.

Clinical Diagnosis	Borderline Tuberculoid (BT)	Mid-Borderline (BB)	Pure Neuritic	Borderline Lepromatous (BL)	Lepromatous Leprosy (LL)	Histoid Hansen's Disease
Total Patients (%)	9 (20.0%)	1 (2.2%)	1 (2.2%)	14 (31.1%)	19 (42.2%)	1 (2.2%)
AFB Negative (%)	9/9 (100.0%)	1/1 (100%)	1/1 (100%)	7/14 (50%)	3/19 (15.79%)	0/1 (0%)
BI 1+	0 (0%)	0 (0%)	0 (0%)	3/14 (6.6%)	0 (0%)	0 (0%)
BI 2+	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
BI 3+	0 (0%)	0 (0%)	0 (0%)	1/14 (7.1%)	1/19 (5.3%)	0 (0%)
BI 4+	0 (0%)	0 (0%)	0 (0%)	2/14 (14.3%)	1/19 (5.3%)	0 (0%)
BI 6+	0 (0%)	0 (0%)	0 (0%)	1/14 (7.1%)	14/19 (73.7%)	1 (100%)

Footnote: In LL cases without well-defined lesions, slit-skin smears were obtained from diffusely infiltrated skin.

suggesting delayed presentation and prolonged disease activity. No ocular disabilities were noted (Table 2).

Bacteriological Index from Ear Lobe Slit Skin Smears

The bacteriological index (BI) from ear-lobe slit-skin smears showed a progressive increase in bacillary load towards the lepromatous pole (Table 3). All BT, BB, and pure neuritic cases were AFB-negative. Among BL cases, 7 of 14 patients (50.0%) were smear-negative, while in LL, 3 of 19 patients (15.8%) were smear-negative. Clinical records revealed that many smear-negative BL and LL patients had been receiving multidrug therapy for 6–10 months before enrolment. Furthermore, several patients gave a history of recurrent unsupervised antibiotic use over the preceding 2–3 years for persistent deformities and neurological symptoms prior to referral to our centre. This likely explains the unexpectedly high proportion of smear negativity despite

multibacillary classification. In LL patients without discrete lesions, slit-skin smears were obtained from bilateral earlobes and diffusely infiltrated skin.

Bacteriological index from lesional slit skin smears

Lesional slit-skin smears showed a BI of 0 in 42.2% of cases, while 33.3% demonstrated a BI of 6+, with the remaining cases falling between BI 1+ and 4+ (Table 4). The BI distribution mirrored that of ear-lobe smears, with increasing smear positivity and bacillary load towards the lepromatous pole. All cases of borderline tuberculoid (BT), and mid-borderline (BB) were AFB-negative. Among borderline lepromatous (BL) cases, half were smear-negative, while the remainder showed BI values ranging from 2+ to 6+. In lepromatous leprosy (LL), only one patient was smear-negative, with most exhibiting high bacillary indices, including BI 6+ in 13 cases (28.9%). The single histoid case showed

Table 4: BI from lesional SSS by clinical diagnosis.

Clinical Diagnosis	Borderline Tuberculoid (BT)	Mid-Borderline (BB)	Pure Neuritic	Borderline Lepromatous (BL)	Lepromatous Leprosy (LL)	Histoid Hansen's Disease
Total Patients n (%)	9 (20.0%)	1 (2.2%)	1(2.2%)	14 (31.1%)	19 (42.2%)	1 (2.2%)
AFB Negative n (%)	9/9 (100%)	1/1(100%)	1/1(100%)	7/14 (50%)	1/19 (5.3%)	0 (0%)
BI 1+ n (%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)	1/19 (5.3%)	0 (0%)
BI 2+ n (%)	0 (0%)	0 (0%)	0 (0%)	2/14 (14.3%)	1/19 (5.3%)	0 (0%)
BI 3+ n (%)	0 (0%)	0 (0%)	0 (0%)	2/14 (14.3%)	1/19 (5.3%)	0 (0%)
BI 4+ n (%)	0 (0%)	0 (0%)	0 (0%)	2/14 (14.3%)	2/19 (10.5%)	0 (0%)
BI 6+ n (%)	0 (0%)	0 (0%)	0 (0%)	1/14 (7.1%)	13/19 (68.4%)	1/1 (100%)

Footnote: Lesional slit-skin smears demonstrated a marginally higher bacillary yield compared with bilateral earlobe smears, particularly in BL and LL forms.

a BI of 6+. SSS negativity in BL and LL cases was predominantly noted among patients already undergoing treatment and those with prior long-term antibiotic exposure.

Comparison of ear-lobe and cutaneous site slit-skin smears

Comparison of bacteriological indices obtained from bilateral ear-lobe slit-skin smears and lesional slit-skin smears showed an overall similar trend, with progressively increasing smear positivity and bacillary load towards the lepromatous end of the spectrum. In both methods, all cases of borderline tuberculoid (BT), mid-borderline (BB), and pure neuritic Hansen's disease were AFB-negative, reflecting the paucibacillary nature of these forms.

Among borderline lepromatous (BL) cases, smear negativity was identical in both techniques,

with 7 of 14 patients (50%) being AFB-negative. However, lesional smears demonstrated a slightly broader distribution of bacillary indices, with BI values ranging from 2+ to 6+, whereas ear-lobe smears showed positivity predominantly at BI 1+, 3+, 4+, and 6+. This suggests a relatively better bacillary yield from active lesional sites in BL disease.

In lepromatous leprosy (LL), lesional slit-skin smears showed marginally higher sensitivity compared with ear-lobe smears. However, in diffuse LL disease lacking discrete lesions, direct comparison between "lesional" and earlobe smears was of limited significance, as smears were obtained from diffusely infiltrated skin rather than from well-defined lesions. Only 1 of 19 LL patients (5.3%) was smear-negative on lesional smears, compared to 3 of 19 (15.8%)

Table 5: Comparative bacteriological index (BI) findings from bilateral earlobe and cutaneous site slit-skin smears in the same patients.

Clinical Diagnosis	Bilateral Earlobe SSS AFB Negative n (%)	Cutaneous Site SSS AFB Negative n (%)	Bilateral Earlobe SSS Highest BI	Cutaneous Site SSS Highest BI	Comparative Interpretation
Borderline Tuberculoid (BT) (n=9)	9 (100%)	9 (100%)	0	0	Both smear sites were uniformly negative, reflecting the paucibacillary nature of BT disease.
Mid-Borderline (BB) (n=1)	1 (100%)	1 (100%)	0	0	Smears from both sites were negative.
Pure Neuritic Hansen's Disease (n=1)	1 (100%)	1 (100%)	0	0	No bacilli detected at either site.
Borderline Lepromatous (BL) (n=14)	7 (50.0%)	7 (50.0%)	6+	6+	Cutaneous site smears demonstrated a broader distribution of BI values, suggesting relatively higher bacillary yield compared with earlobe smears.
Lepromatous Leprosy (LL) (n=19)	3 (15.8%)	1 (5.3%)	6+	6+	Cutaneous site smears showed slightly higher positivity than bilateral earlobe smears. In diffuse LL disease, smears were obtained from infiltrated skin rather than discrete lesions.
Histoid Hansen's Disease (n=1)	0 (0%)	0 (0%)	6+	6+	Both smear sites demonstrated heavy bacillary positivity.

Footnote: In patients with clinically well-defined lesions, cutaneous slit-skin smears were obtained from the active infiltrated margin of representative lesions. In diffuse lepromatous leprosy without discrete lesions, smears were obtained from diffusely infiltrated skin at standard cutaneous sites. Bilateral earlobes were sampled in all patients.

on ear-lobe smears. High bacillary indices predominated with both techniques, although BI 6+ was slightly more frequent in ear-lobe smears (73.7%) than lesional smears (68.4%). The single

Table 6: Correlation between clinical and histopathological diagnoses in various classes of leprosy.

Diagnosis	Clinical Diagnosis (n)	Histopathological Diagnosis (n)
Borderline Tuberculoid (BT)	9	14
Mid-Borderline (BB)	1	0
Borderline Lepromatous (BL)	14	10
Lepromatous Leprosy (LL)	19	18
Histoid Hansen's	1	1
Pure Neuritic	1	1

Footnote: Clinically diagnosed case of BB Hansen's showed non-specific chronic inflammation without granuloma or demonstrable bacilli on HPE.

histoid Hansen's disease case demonstrated BI 6+ positivity on both smear sites (Table 5).

Overall, lesional slit-skin smears appeared to provide a modestly higher bacillary yield, particularly in BL and LL forms, while both techniques showed comparable trends across the disease spectrum. Persistent smear negativity in some multibacillary patients despite clinical classification was likely attributable to prior multidrug therapy and repeated undocumented antibiotic exposure before presentation.

Histopathological Diagnosis

Histopathological examination confirmed LL in 18 cases, BT in 14 cases, BL in 10 cases, and one case each of histoid Hansen's disease and pure neuritic leprosy. No histopathological evidence of leprosy was observed in one clinically diagnosed BB case (Table 6).

Histopathological discordance was observed predominantly within the borderline spectrum, which is expected because of the immunologically unstable nature of borderline disease.

The clinically diagnosed BB patient who showed no histopathological evidence of leprosy had received partial treatment previously and biopsy from the sampled lesion showed only non-

specific chronic inflammation without granuloma or demonstrable bacilli. Clinically, the patient had three asymmetrical plaques with sensory impairment and thickened ulnar nerve. However, in view of the characteristic clinical features and neural involvement, multidrug therapy for multibacillary leprosy (MB-MDT) was continued and completed for 12 packs. Moreover, the patient belonged to endemic area.

Discussion

Leprosy presents with a wide clinico-pathological spectrum, and accurate classification remains challenging, particularly in borderline forms. This study evaluated the correlation between clinical diagnosis, bacteriological index derived from slit skin smears at different sites, and histopathological findings, with histopathology considered as gold standard.

The study population predominantly comprised individuals in the economically productive age group, with a marked male predominance. This demographic pattern is consistent with previous Indian studies and likely reflects occupational exposure and health-seeking behavior rather than true gender susceptibility (Kakkad et al 2016, Jindal et al 2009, Sharma et al 2018, Semwal et al 2018, Atram et al 2020). A higher proportion

of patients belonged to lower socioeconomic and educational strata, reinforcing the well-established association of leprosy with social disadvantage (Majumder 2015), however, these observations were not the primary focus of the present analysis.

Clinically, multibacillary disease predominated, with lepromatous (LL) and borderline lepromatous (BL) forms accounting for over two-thirds of cases. Similar patterns were reported by Jindal et al (2009). This distribution contrasts with studies reporting a higher prevalence of borderline tuberculoid (BT) disease (Shah et al 2023) and may indicate delayed presentation or referral bias. The predominance of multibacillary forms has epidemiological significance due to their higher transmission potential.

Slit skin smear examination demonstrated a clear relationship between bacteriological index and clinical spectrum. All BT and pure neuritic cases were smear-negative from ear lobes, whereas BL, LL, and histoid cases showed higher BI values, particularly BI 6+. While Shah B et al (2023) reported lower rates of high BI values, our findings likely reflect delayed diagnosis or more advanced presentations in our cohort.

Slit-skin smear findings in the present study demonstrated a progressive increase in bacteriological positivity toward the lepromatous pole, consistent with the established understanding that bacillary load correlates with the immunological spectrum of Hansen's disease. Earlobe smears were uniformly negative in BT and BB cases, whereas representative cutaneous site smears occasionally demonstrated positivity in borderline lesions. Mahajan (2013) also emphasized the importance of obtaining smears from clinically active lesions in localized disease to improve bacteriological yield. These findings highlight that lesion-directed sampling may provide additional diagnostic value in borderline

forms where bacillary distribution is often focal and uneven.

In LL disease, positivity was observed both from earlobes and diffusely infiltrated skin, however, BI of 6+ was observed in SSS from ear lobes. Since LL patients frequently lack well-defined lesions, comparison between "lesional" and earlobe smears may not always be appropriate in diffuse disease. In such cases, smears obtained from multiple infiltrated sites along with bilateral earlobes provide a better assessment of bacillary load. Mahajan (2013) also emphasises that slit-skin smear examination from multiple representative sites remains important in multibacillary disease because bacillary distribution may vary according to the site sampled.

An important observation in the present study was smear negativity among several clinically diagnosed BL and LL patients. Approximately 50% of BL cases and 15.8% of LL cases were smear-negative from earlobes despite belonging to the multibacillary spectrum. Many of these patients had received MDT-MB for 6–10 months before study enrolment. In addition, a history of repeated prolonged antibiotic therapy for persistent deformities and neuropathic complaints was frequently documented before presentation to our tertiary care centre. Prior treatment with consequent reduction in bacillary load probably explains these findings. Similar reduction in bacteriological positivity following treatment has been described previously, although BL and LL patients usually remain smear positive for prolonged periods depending upon bacillary burden and treatment duration (Rajan & Ponnaiya 2023, Khurana 2021). Additionally, technical factors related to slit-skin smear collection and staining procedures may also have contributed to smear negativity in some cases.

Histopathological discordance was most prominent within the borderline spectrum, which

is well recognized because of immunological instability and overlapping clinicopathological features in borderline disease (Poudel et al 2019, Semwal et al 2018). In contrast, polar forms such as LL and histoid Hansen's disease showed better clinicopathological correlation, consistent with previous studies by Sharma et al (2008), Prajapati et al (2021), Naik et al (2022) and Shah et al (2023), where concordance was highest in stable polar forms of leprosy.

A large number of studies on clinical, histopathological and bacteriological aspects in different types of leprosy are available. Our study highlights the current scenario from this tertiary care centre. This recent information is relevant for teaching and training of students as well as practicing doctors involved in diagnosis and management of leprosy.

Conclusion

Clinical examination remains the cornerstone for diagnosis and treatment initiation in Hansen's disease. However, histopathological examination provides valuable support for accurate classification, particularly within the borderline spectrum. Slit-skin smear findings vary according to clinical type, site of sampling, and prior treatment status. In localized disease, smears from active lesions may demonstrate higher bacillary yield than earlobe smears, whereas in diffuse lepromatous disease, smears from infiltrated sites and earlobes remain useful for bacteriological assessment. An integrated clinicopathological and bacteriological approach remains essential for accurate diagnosis and classification of Hansen's disease.

Limitations

The sample size was limited. Additionally, inter-observer variability in histological interpretation and smear grading may influence diagnostic consistency.

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