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Spectrum of histopathological lesions in Hansen's disease: A tertiary care center study

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Abstract
Background: Hansen's disease (HD) remains a significant public health concern with variable clinical presentations. Accurate histopathological diagnosis is essential for appropriate management.
Aims and Objective: This study aimed to characterise the spectrum of histopathological lesions in Hansen's disease.
Methods: A retrospective study was conducted in the Department of Pathology (Histology section), at B.J. Medical College and Civil Hospital, Ahmedabad, from June 2024 to December 2024, including a total of 100 cases were included. All the received punch biopsy specimens were processed and stained with Hematoxylin & Eosin and Fite-Faraco stains, and then evaluated under a microscope. Histological classification was done according to the Ridley-Jopling system, and bacterial index was determined using the logarithmic scale.
Results: The most common form was Lepromatous Leprosy (37%), followed by Tuberculoid Leprosy (30%), and Borderline Leprosy (24%). Male-to-female ratio was 1.7:1, with peak incidence in the 31-40 years age group (29%). Neural involvement was present in 70% of cases, being highest in Lepromatous Leprosy (78.37%). Multibacillary cases comprised 61% of the study population. Lepra reactions were observed in 12% of cases, with Type II (ENL) reactions being more common (83.33%) than Type I reactions (16.67%).
Conclusion: Histopathological examination remains the gold standard for Hansen's disease diagnosis and classification. The identification of the immunopathological spectrum from tuberculoid to lepromatous forms and the detection of reactive episodes are crucial for accurate classification and therapeutic intervention. This study emphasises the indispensable role of histopathology in definitive diagnosis, particularly in borderline and indeterminate forms.

Keywords: Hansen's disease, leprosy, *Mycobacterium leprae*, bacterial index, Ridley-Jopling classification, lepra reactions

Introduction

Hansen's Disease (HD), commonly known as leprosy, is a chronic infectious disease caused by *Mycobacterium leprae*. Named after the Norwegian physician Gerhard Armauer Hansen, who discovered the causative bacillus in 1873, leprosy remains one of the most significant causes of physical disability and social stigma worldwide. The disease primarily affects the skin and peripheral nervous system but may involve virtually any organ, including the eyes, internal organs, and endocrine glands. The clinical manifestations of leprosy are remarkably diverse and variable, ranging from insignificant skin lesions to extensive disease causing profound disability and deformities. While clinical examination provides valuable information based on the gross morphology of lesions, histopathological evaluation offers a comprehensive understanding by incorporating immunological parameters, thereby enabling accurate classification and staging of the disease. The discovery that leprosy presents as an immunological spectrum was one of the most significant advances in understanding infectious diseases. The Ridley-Jopling classification system, based on clinical, histopathological, microbiological, and immunological criteria, divides leprosy into five major types: Tuberculoid (TT), Borderline Tuberculoid (BT), Borderline (BB), Borderline Lepromatous (BL), and Lepromatous (LL), with Indeterminate (IL) and Histoid variants representing early and unusual presentations, respectively. Histopathological study of Hansen's disease is essential for several reasons:

It provides confirmatory information in suspect cases that may be missed clinically, enables exact typing of the disease, helps assess progression and regression under treatment, and facilitates early detection of reactive episodes. The bacterial index (BI), determined by microscopic examination of stained sections, serves as a prognostic indicator and a marker of treatment efficacy. This study was undertaken to characterise the spectrum of histopathological lesions in Hansen's disease presenting to a tertiary care teaching hospital, to determine the bacterial index in various types, and to identify reactive episodes. The findings contribute to a better understanding of disease presentation patterns in our geographic region and highlight the indispensable role of histopathology in disease diagnosis and management.

Materials and Methods

Study Design and Settings

A retrospective study was conducted at the Department of Pathology in B.J. Medical College and Civil Hospital, Ahmedabad, Gujarat, over a period of 7 months (June 2024 to December 2024) where a total of 100 cases were included. All received punch biopsy specimens were collected, processed and stained with Hematoxylin & Eosin and Fite-Faraco stains and then evaluated under a microscope.

Selection criteria of patients

- **Inclusion Criteria:** All patients clinically suspected of or diagnosed with Hansen's disease
- **Exclusion Criteria:** Autolysed or inadequate biopsy specimens

Results

The study included 100 cases of Hansen's disease over a period of 7 months for histological examination which was included in the present study. Age distribution revealed that Hansen's disease showed a predilection for the middle-aged population. The disease was most common in the 31-40 years age group (29%), followed closely by 21-30 years (23%) and 41-50 years (21%). Notably, disease incidence was lowest in children aged 1-10 years (1%). Peak incidence in middle ageed groups suggests delayed manifestation and diagnosis, consistent with the chronic nature of *Mycobacterium leprae* infection and variable incubation period.

Leprosy showed distinct male predominance with 63 males (63%) and 37 females (37%), yielding a male-to-female ratio of 1.7:1. This male predominance is attributed to greater occupational exposure, higher social mobility, and contact with potentially infectious individuals in males.

Neural involvement was observed in 70 out of 100 cases (70%), demonstrating pronounced tropism of *Mycobacterium leprae* for peripheral nerves.

Table 1: Gender distribution across various types of Hansen's disease

Type	Male	Female	Ratio
TT	17	13	1.3:1
BT	2	3	1:1.5
BB	2	5	1:2.5
BL	8	4	2:1
LL	29	8	3.6:1
Histoid	2	2	1:1
IL	3	2	1.5:1

Table 2: Age-wise distribution

	Cases
0-10	1
11-20	9
21-30	23
31-40	29
41-50	21
51-60	7
61-70	4
71-80	6
81-90	0
91-100	0
Total	100

Table 3: Frequency of nerve involvement in various types

Type	Total cases	Neural Involvement
TT	30	20
Borderline	24	15
LL	37	29
Histoid	4	3
IL	5	3
Total	100	70

The highest incidence was in Lepromatous Leprosy (78.4%), followed by Histoid Leprosy (75%). Histopathologically, nerves showed intraneural granulomatous infiltration, Schwann cell involvement, and a degree of nerve destruction correlating with disease type.

Discussion

Spectrum of Histopathological Lesions

The study identified seven distinct histopathological types of Hansen's disease as per Ridley-Jopling classification.

Lepromatous Leprosy (LL)

37 cases (37%) Histopathological Features: Marked epidermal atrophy with well-preserved dermal epidermal junction, characteristic clear subepidermal (Grenz) zone separating epidermis from infiltrate, and dense macrophage-predominant granulomas with scant lymphocytes. Macrophages with clear cytoplasm (Virchow cells/lepra cells) became foamy and vacuolated with time. Minimal reactive proliferation around nerve bundles was observed. Acid-fast bacilli (AFB) were present in clumps (globi) within macrophages, Schwann cells, endothelial cells, and cutaneous appendages. Marked perineural infiltration with onion skin appearance of perineurium was noted. Bacterial index: Consistently high BI of 5-6+ reflecting heavy bacillary burden.

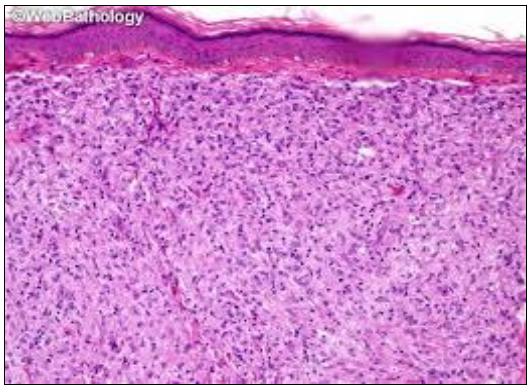

Fig 1: Mass of macrophages in the dermis, leaving a clear Grenz zone in the epidermis

Tuberculoid Leprosy (TT)
30 cases (30%) Histopathological Features: Epidermal atrophy with deep erosion in areas beneath granulomas, well-organized epithelioid cell granulomas with prominent Langhans giant cells, and dense lymphocytic infiltration surrounding granulomas. Granulomas extended to the dermal-epidermal junction without intervening clear zone. Marked infiltration and destruction of skin appendages (nerves, hair follicles, sweat glands) was prominent. Intraneural inflammation with Schwann cell replacement by epithelioid cells was characteristic. AFB were scanty or absent on Fite-Faraco staining. Bacterial index: 0 (paucibacillary) in all 30 cases.

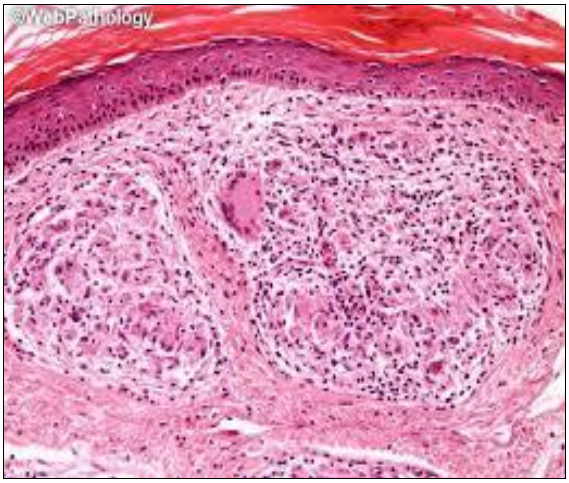

Fig 2: Typical endoneuritits with granulomas eroding into the nerve

Borderline Tuberculoid Leprosy (BT)
5 cases (5%) Histopathological Features: Variable epidermal atrophy depending on granuloma extent, poorly organized epithelioid granulomas with infrequent tuberculoid organization, predominance of foreign body giant cells over Langhans type, moderate nerve swelling with granulomatous infiltration or Schwann cell proliferation only. Grenz zone was rarely present, distinguishing it from tuberculoid leprosy. Bacterial index: 1-2+ (paucibacillary to low multibacillary).

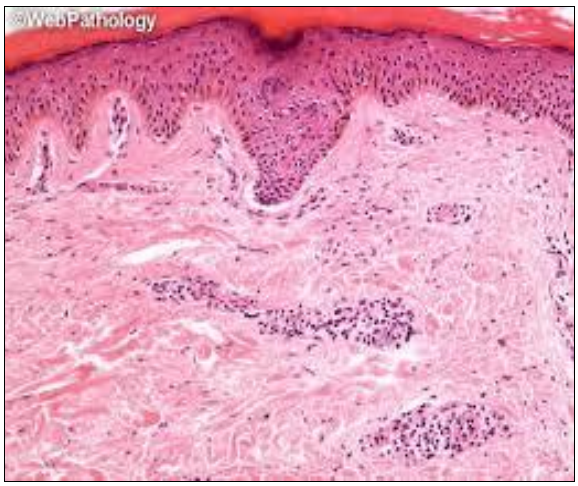

Fig 3: Lymphocytes along superficial vascular plexuses

Borderline Leprosy (BB)
7 cases (7%) Histopathological Features: Variable epidermal atrophy, distinctive clear subepidermal zone without giant cells, diffuse epithelioid cell granulomas with scant lymphocytes, and absence of well-formed giant cells. Reactive proliferation and edematous thickening of perineurium around affected nerves was observed. AFB were demonstrable in Schwann cells and macrophages within granulomas. This was the most unstable type with highest propensity for downgrading. Bacterial index: 3-4+ (multibacillary).

Borderline Lepromatous Leprosy (BL)
12 cases (12%) Histopathological Features: Epidermal atrophy almost always present, clear well-de ned Grenz zone of normal dermis, macrophage-predominant granulomas with minimal epithelioid component, and some macrophages showing foamy change. Marked perineural cell proliferation with concentric layers (onion-skin perineurium) was characteristic. Many perineural collections of macrophages were noted. AFB were plentiful, often in clumps and globi. Bacterial index: 4-5+ (multibacillary).

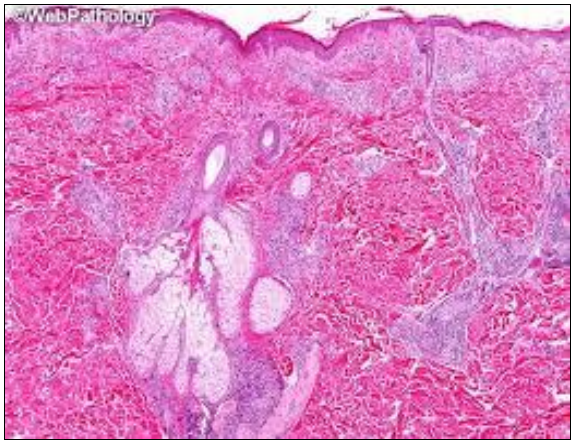

Fig 3: Lymphohistiocytic infiltrate around neurovascular bundles in dermis

Histoid Leprosy
4 cases (4%) Histopathological Features: Firm erythematous nodular lesions clinically, interlacing bundles of spindle-shaped cells arranged in crisscross or whorled pattern, cells resembling fibroblasts but staining as macrophages, presence of pseudocapsule of dermal collagen surrounding nodules. Resembled dermatofibroma on conventional staining but differentiated by Fite-Faraco staining. Bacterial index: 6+ (highest bacillary burden), found exclusively in relapsing cases or drug-resistant disease.

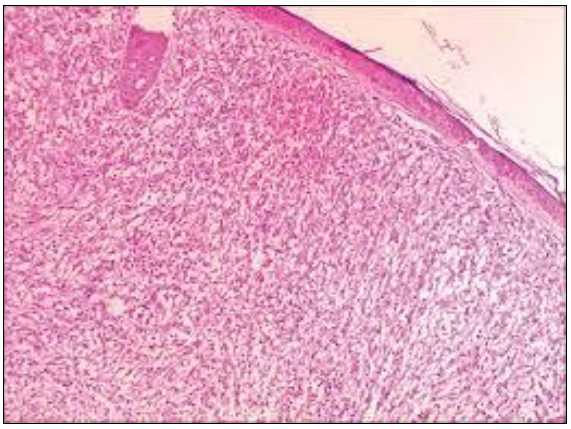

Fig 4: Histoid lesion with spindle cell proliferation of macrophages, resembling storiform tumor

Indeterminate Leprosy

5 cases (5%) Histopathological Features: Early transitory form with incomplete immunological response, one to three ill-defined hypopigmented macules, nonspecific histiocytic and lymphocytic infiltration in epidermis, small cutaneous nerve bundle with perineural lymphocytic infiltration, and perineural infiltration with round cells and hypoplasia of Schwann cells. AFB were scanty or absent. Bacterial index: 0 (paucibacillary).

Lepra Reactions

Lepra reactions represented episodes of acute inflammation superimposed on chronic leprosy. In this study, 12 cases (12%) showed histological features of lepra reactions. Type I Reaction (Reversal Reaction)-2 cases (16.67% of reactions): Associated with delayed-type hypersensitivity (Type IV), characterized by upgrading (shift toward tuberculoid pole) or downgrading (shift toward lepromatous pole) phenomena. Histological features included dermal and intra-granuloma oedema, proliferation of epithelioid cells and larger Langhans giant cells, increased lymphocytic infiltrate, and fibrinoid necrosis within granulomas and dermal nerves.

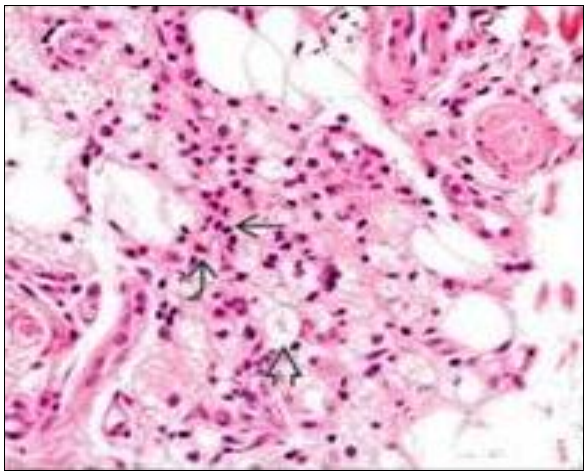

Fig 6: Foamy macrophages with polymorphonuclear cell infiltrate in Erythema *Nodosum Leprosum*

Cases identified

1 BB-Type I upgrading reaction with BI +1 and 1 BB-Type I downgrading reaction with BI +4. Type II Reaction (Erythema *Nodosum Leprosum*/ENL)-10 cases (83.33% of reactions): Associated with immune complex-mediated hypersensitivity (Type III), occurring exclusively in lepromatous and borderline lepromatous patients. Histological features included acute inflammatory infiltrate superimposed on chronic multibacillary leprosy, neutrophilic infiltration with variable density, vasculitis affecting small and medium vessels, dermal oedema and purulent inflammation, and possible dermal abscess formation with ulceration. Cases identified: 1 BL with Type II (ENL) reaction at BI +5 and 9 LL with Type II (ENL) reaction (4 cases at BI +5 and 5 cases at BI +6).

Conclusion

This study reinforces that histopathological examination remains the gold standard for Hansen's disease diagnosis and classification. The spectrum of lesions from tuberculoid (strong CMI) to lepromatous (absent CMI) demonstrates the remarkable plasticity of host immune response to *Mycobacterium leprae* infection. The identification of reactive phenomena underscores the dynamic nature of the disease. Integration of histopathology with clinical findings, bacteriology, and immunological assessment provides comprehensive understanding essential for optimal patient management and effective disease control. Healthcare providers managing leprosy patients should advocate for histopathological conformation, particularly in borderline and atypical presentations, to ensure accurate classification and appropriate therapeutic intervention.

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Conflict of Interest

Not available

Financial Support

Not available

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