ISSN: 2581 – 3633
PubMed - National Library of Medicine - ID: 101745081

International Journal of Medical Science and Advanced Clinical Research (IJMACR)

Available Online at: www.ijmacr.com

Volume – 6, Issue – 1, Janaury - 2023, Page No. : 40 - 48

Clinico-Radiological Study of Bone Involvement in Hansen's disease

[1]Dr. Shibe Ganesh S, Postgraduate Resident, Department of Dermatology, Venereology and Leprology (DVL), Guntur Medical College, Guntur, Andhra Pradesh, India – 522004.

[2]Dr. Mohana Rao TS, Professor and HOD, Department of Dermatology, Venereology and Leprology (DVL), Guntur Medical College, Guntur, Andhra Pradesh, India – 522004.

[3]Dr. Hanuma Naik K, Associate Professor, Department of Dermatology, Venereology and Leprology (DVL), Guntur Medical College, Guntur, Andhra Pradesh, India – 522004.

Corresponding Author: Dr. Mohana Rao TS, Professor and HOD, Department of Dermatology, Venereology and Leprology (DVL), Guntur Medical College, Guntur, Andhra Pradesh, India – 522004.

How to citation this article: Dr. Shibe Ganesh S, Dr. Mohana Rao TS, Dr. Hanuma Naik K, "Clinico-Radiological Study of Bone Involvement in Hansen's disease", IJMACR- January - 2023, Volume – 6, Issue - 1, P. No. 40 – 48.

Type of Publication: Original Research Article

Conflicts of Interest: Nil

Abstract

Background: Bone changes, both specific and non-specific, are important prognostic factors in Hansen's disease. While deformities are the end result of bone involvement, identifying these bone changes before deformities settle-in can affect prognosis favourably. **Aims and objectives:** To study the bone changes in hands and feet of leprosy patients, to correlate them with clinical characteristics and to explore the early radiological signs that can precede deformities. **Materials and methods:** Prospective observational study from January 2021 to June 2022 was conducted at Department of DVL, Guntur Medical College. 100 leprosy patients irrespective of their treatment status were enrolled and X-Rays of both hands and feet were taken.

Results: Among 100 cases, 63 were males and 37 were females. Age range was 17-67 years with mean of 40 years. 35 patients showed clinical deformities. Overall, 36% cases showed bone changes (specific-12%, non-specific-20%, osteoporosis-17%) with male preponderance. Bone changes increased with age and disease duration. Bones were more commonly involved towards lepromatous pole (BB-50%, BL-56%, LL-52.6%) and in default (83.3%) and relapse (80%) cases. While all patients with clinical deformities showed radiological findings, 17% patients without any clinical deformities were found to have atleast one radiologically significant change (specific-5%, non-specific-9%,osteoporosis-9%).

Conclusion: While traditionally X-Rays are done in leprosy patients with deformities to know the extent of

involvement, early judicial use of X-Rays before deformities occur may aid other clinico-diagnostic methods in handicap prevention.

Keywords: Leprosy, Bone changes, Deformities, Radiological findings, Handicap prevention

Introduction

Leprosy is a chronic bacterial infection caused by*Mycobacterium leprae*that evokes both localized and widespread granulomatous reaction of self-limiting or progressive nature depending on the host immunological status. The disease can result in progressive, irreversible physical abnormalities that have major social and economic repercussions [1].

Bone changes occurring in leprosy could either be specific or non-specific based on the pathophysiology. Nearly 25% patients infected with the disease, who fail to get early treatment,progress to develop deformities especially of the hands and feet [2]. The frequency of bone changes has been reported to widely vary between 15% and 95% across various studies [3]. Several factors influence the occurrence and progress of bone changes in leprosy. While most of these changes are relatable to the disease duration, in rest of the cases, bone could be an early site of involvement.

Roentgenogram (X-Ray) is a non-invasive diagnostic technique that is widely available at all levels of health care. Various studies have elucidated the common bone changes as observed in X-Rays among leprosy patients with pre-existing limb deformities [3][4][5][6]. Several reports have also favoured bone changes early in the course of leprosy and in patients even without evident deformities [7][8][9][10].

Pathophysiologically, bone can be affected much early during the disease process andbone involvement can progress even after several years of completing specific pharmacotherapy for the disease [11][12]indicating that such treatment is necessarybut not sufficient to cure the bone lesions.

The current study focuses on elucidatingthe radiographic bone changes in leprosy irrespective of disease duration and presence of deformity.The study also aims to identify those early changesthat might precede deformities and thus might be helpful in instituting early physiotherapy.

Materials and Methods

A prospective observational study was conducted for a period of 18 months from January 2021 to June 2022 at the Department of DVL, Guntur Medical College, Guntur, AP. After obtaining clearance and approval from the Institutional Ethics Committee, 100 patients diagnosed with Hansen's disease irrespective of their treatment status were chosen and enrolled for the study. All patients were explained about the purpose of study, procedure of clinical examination and investigations to be done. Informed and written consent was taken and documented from all cases.

Data regarding socio demographic characteristics were recorded. Detailed history was taken and a thorough clinical examination was carried out in all patients to look for skin lesions, sensorimotor impairment, deformities and other autonomic changes. Peripheral nerve examination was carried out to look for thickness, consistency, nodularity, suppuration and tenderness. Ocular examination was carried out and visual acuity was recorded.

Slit Skin Smear was performed from the ear-lobule and skin lesion. Modified Ziehl-Neelsen's staining procedure was performed to look for Acid Fast Bacilli (AFB) and Bacillary Index(BI) was noted. Punch biopsy from representative skin lesion was taken and sent for

histopathological confirmation (HPE). For old patients on follow-up, their prior HPE reports were collected. Nerve Conduction Studies (NCS) of peripheral nerves were done in doubtful cases.

Plain digital radiographs of both hands and feet were taken and analysed for the presence of bone changes. Radiological opinion was obtained from experts who were blinded to the clinical details of patients.

Results

Sample Epidemiology

A total of 100 leprosy cases were included in the study. 63 were males and 37 were females. Age range was 17-67 years with mean age of 40 years (39.7). Most common age group was 30-39 year(27%) followed by 20-29 year (24%). Male predominance was observed across all age groups. There were no cases under 10 years of age. 41% patients belonged to the lower socioeconomic strata (Modified Kuppuswamy Classification). Manual labour (30%) and farming (27%) were the most common occupations observed.

Clinical Spectrum

Of the 100 cases, 31 were Borderline-Tuberculoid(BT), 25 were Borderline-Lepromatous(BL), 19 were Lepromatous(LL), 14 were Pure-Neuritic(PNH), 6 were Mid-Borderline(BB) and 5 were of Histoid type. 22 patients presented with reaction (Type-1-reaction: 14, Type-2-reaction: 8).

39 patients were newly diagnosed. Of the remaining 61 patients, 22 were on active Multi Drug Therapy(MDT), 28 were released from treatment (on surveillance), 6 were default cases and 5 were confirmed relapse cases.

Skin patch was the most common clinical feature noted(86%) followed by sensory abnormalities(48%) and xerosis(37%). 35 patients presented with deformities of which 23 had deformities of hands and feet, 4 had leonine facies and 5 had madarosis.

Bone Changes

36% patients showed radiographical changes (males-24, females-12).12 patients showed specific bone changes, 20 showed non-specific bone changes and 17 showed evidence of osteoporosis. 7 patients in 20-29 year group and 8 patients each in 30-39, 40-49, 50-59 year age groups showed bone changes. However, no patient under 20 years showed bone change while 5 patients above 60 years showed bone change.

Among 36 patients with bone changes, 39% belonged to BL, 28% LL, 17% BT, 8% BB, 5% PNH and 3% Histoid. With regards to the treatment status, 33% patients with bone changes were released from treatment, 22% were on treatment while 20% were newly diagnosed.

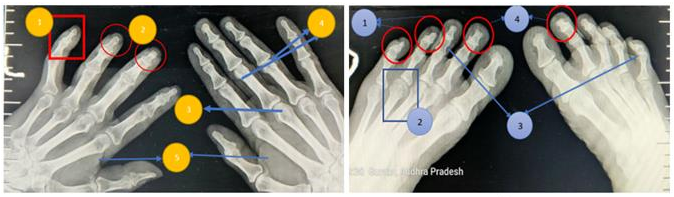
Primary periostitis, honeycombing, bone cysts, cortical irregularities/thinning, concentric cortical erosions, areas of bone destruction and sclerosis were the specific bone changes observed. Non-specific bone changes noted were absorption of phalanges, soft tissue changes, claw hand/claw toe, tuft erosion, arthritis, joint subluxation, fractures and osteomyelitis.

All patients with deformities showed bone changes while 17% patients without deformities showed bone changes.

Image 1 shows specific and non-specific bone changes in hands and feet without any clinical deformities.

Image 2 shows bone changes in a patient with pre-existing clinical deformities.

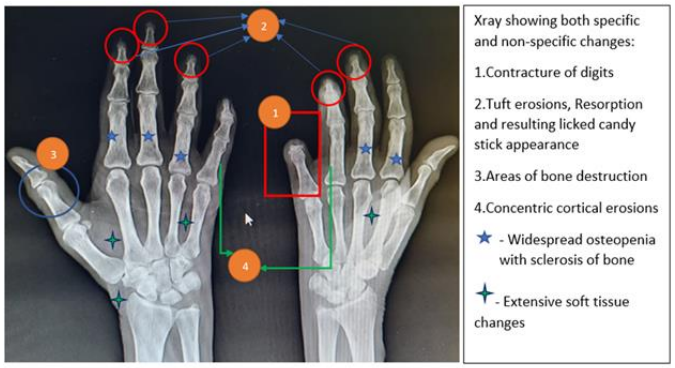
Figure 1: Bone changes without clinical deformities:



(a) (b)

(a). 1. Licked candy stick appearance 2. Tuft erosions 3. Bone cyst 4. Cortical irregularities 5. Soft tissue changes

(b). 1. Absorption of phalanges 2. Honeycombing 3. Areas of bone destruction along with sclerosis 4. Tuft erosions



Specific and non-specific bone changes in a patient who presented with bilateral claw hand and infected callosities.

Figure 2: Bone changes with clinical deformities:

Deformities

Bone Change	Cases with hand/feet deformities(a)	Incidence (a)n=23	Cases without deformities(b)	Incidence (b)n=77
Specific Bone Changes				
Primary periosteitis	4	17.3 %	1	1.3 %
Honeycombing	4	17.3 %	0	
Bone cyst	3	13 %	0	
Cortical irregularity/thinning	6	26 %	4	5.19 %
Concentric cortical erosions	4	17.3 %	2	2.59 %
Area of bone destruction	2	8.7 %	3	3.89 %
Sclerosis	3	13 %	3	3.89 %
Non-specific bone changes				
Absorption of phalanges	11	47.8 %	5	6.5 %
Soft tissue changes	10	43.4 %	7	9 %
Claw toes/hands/contracted fingers	10	43.4 %	0	
Tuft erosion	9	39 %	3	3.8 %
Evidence of arthritis	4	17.3 %	3	3.8 %
Joint subluxation/ dislocation	2	8.7 %	4	5.2 %
Fractures	1	4.3 %	2	2.6 %
Evidence of osteomyelitis	5	21.7 %	2	2.6 %
Osteoporosis	10	43.4 %	7	9 %

Discussion

Socio-Demographic Characteristics

The global male female ratio in leprosy according to WHO is 2:1 [13].The current study results (63:37) also reiterate this fact that leprosy is twice as common in males as in females. The mean age in the present study was 40 years. This is consistent with that of Mohammed et al[4] (41.7 years). The most common decadal age

group affected in this study was 30-39 years which was closely followed by 20–29-year and 40–49-year age groups which is consistent with the findings of Ankad et al[3] and RanjanKumar et al[14]. All this data reiterates that leprosy peaks between 20 and 40 years of age.

Most patients in the present study belonged to the lower socioeconomic strata. Overcrowding, lifestyle, environmental exposure, lack of awareness, social restriction, ignorance and stigma are possible factors responsible for leprosy being more prevalent in the deprived sections.

Manual labour was the most common occupation observed in this study. A similar finding was noted by Mohammed et al [4] and Reddy et al [6].This might be because manual laborers are more vulnerable to develop trophic ulcers due to their insensitive skin making them seek healthcare facility more frequently.

Clinical Characteristics

We observed BT to be the most common type of leprosy (36%) followed by BL and LL (25% and 19%). Ankad et al [3]made a similar observation while Mohammad et al [4] noted LL to be more common. BB was the least common type noted. BB being an unstable category is subjected to frequent downgrades and upgrades along the leprosy spectrum. This justifies the low prevalence of BB observed in this study.The prevalence of PNH in the current study was 14%.This is in congruencewith that of prior studies that PNH is commoner in South-India.

Bone Changes in Leprosy

The present study noted a 36% overall prevalence of bone changes in leprosy. A wide variation in the prevalence of bone changes was observed by various investigators: Chamberlein et al [16]-15%, Fagot and Mayoral [17] – 29%,Paterson et al [18]–95%, Basu et al [19]–91%, Thappa et al [15]–82.9%, Choudhuri et al [5]–87.3%, Ankad et al [3]–96%, Mohammad et al [4]– 90%, Ranjan Kumar et al [14]–100% and Reddy et al [6]–42%.

Available data indicate that most of the previous studies were conducted among patients with deformities. Current study included all cases of Hansen's disease except since the aim was to explore the possible early bone changes and hence the lower prevalence is justified. Reddy et al[6] conducted a similar study among all leprosy cases and observed bone changes in 42.8% which is comparable to the current study result.

In the current study, 38% males(n=63) and 32% females(n=37) showed radiographic bone changes. There was no significant gender difference in the prevalence of bone changes. This is consistent with the observation of Mohammad et al [4] .

We observed maximum overall prevalence in 50–59-year group(57.14%) and minimum prevalence in 10–19-year group(0%). This indicated that prevalence of bone changes increases as age of the patient increase. This might be because bones tend to get weaker with age and get predisposed to the leprous pathology.

We observed the prevalence of bone changes to be maximum in the BL group(56%) closely followed by LL group(52.6%). Minimal overall prevalence was noted in PNH(14.2%) and BT group(19.3%). Thus, bone changes were more prevalent towards the lepromatous pole in the current study. Mohammad et al[4] and B.Reddy et al[6] made a similar observation while Ankad et al[3]noted bone changes to be common in borderline group.

Table 2: Spectrum specific prevalence of bone change -Current &previous studies

	BT	BB	BL	LL	PNH	Histoid
Present study:						
Specific bone changes	9.6%	16.6%	12%	21%	7.1%	0%
Non-specific bone changes	12.9%	33.3%	28%	21%	14.2%	40%
Ankad et al [5]:						
Specific bone changes	56.6%	100%	66.6%	100%	60%	-
Non-specific bone changes	96.6%	-	91.6%	100%	100%	-
Choudhuri et al [7]:						
Specific bone changes	45%	-	-	75%	-	-
Non-specific bone changes	76.5%	-	50%	100%	-	-
Chabbriya et al [20]:						
Specific bone changes	25%	25%	-	37%	50%	-
Non-specific bone changes	-	-	-	-	-	-
Thappa et al [15]:						
Specific bone changes	-	-	-	-	-	-
Non-specific bone changes	64.3%	-	80%	26.7%	-	-

In our study, bone changes were significantly more prevalent among defaulters (83.3%) and relapsedleprosy cases (80%). Both these categories are representative of high bacillary load or recalcitrant disease process or issues with treatment compliance. These patients are thus prone to have continued disease pathology and a resulting high incidence of bone changes.

We observed bone changes to be more common with increasing disease duration. These findings are comparable to that of Mohammad et al [4] and Ankad et al [3]. This reiterates the need for early intervention to reduce deformities and the resulting handicap.

The current study found majority of bone changes in leprosy to be non-specific in nature. This is highly consistent with the observations of all previous investigators.

Table 3: Specific and Non-specific bone changes- Current Study and Previous studies

Bone change	Present study	Paterson et al [18]	Chchabriya et al [20]	Thappa et al [15]	Chaudhuri et al [5]	Mohammed et al [4]	Ankad et al [3]
Specific bone changes							
Bone cyst	3%	2.8%	22.0%	10.5%	22.7%	36.0%	16%
Primary periostitis	5%		4 %	1.3%	28.2%	14%	42%

Concentriccorticalerosion	6%	0.2%	8.0%	1.3%	10.0%	10.0%	50%
Honeycombing	4%	3.0%	6.0%	-	-	46.0%	6%
Cortical irregularities/thinning	10%		4.0%	-	-	28.0%	60%
Areas of bone destruction	5%	1.0%	8.0%	-	-	20.0%	36%
Sclerosis	6%	2.6%	14.0%	-	-	16.0%	24%
Non-specific bone changes							
Absorption of phalanges (avg)	16%	8.6%	72%	37.7%	30%	30%	65%
Soft tissue changes	17%	-	74.0%	39.5%	44.5%	16.0%	80%
Claw toes/hand	10%	-	38.0%	36.8%	22.7%	64.0%	58%
Tuft erosion	12%	27.0%	56.0%	15.8%	13.6%	32.0%	86%
Arthritis	7%	10.0%	10.0%	14.5%	26.4%	18.0%	36%
Sub luxation and/or dislocation	6%	4.5%	28.0%	10.5%	18.2%	32.0%	30%
Fractures	3%	-	4.0%	6.6%	3.6%	4.0%	12%
Osteomyelitis	7%	5.6%	14.0%	5.3%	4.5%	6.0%	20%

In the present study, cortical irregularities and thinning were the most common specific bone changes. This was followed by a near equal prevalence of concentric cortical erosions, sclerosis and areas of bone destruction. These findings are consistent with that of Ankad et al [3].However, Mohammad et al [4] and Choudhuri et al [5] observed honeycombing and primary periostitis to be more common. This wide variation among studies might suggest that each specific-bone change might be having a peculiar pathogenetic mechanism influenced by a multitude of genetic, environmental and microbiological factors.

In our study, soft tissue changes and absorption of phalanges were the most common non-specific radiographic abnormalities. Chabbriya et al[20]and Ankad et al [3]also made a similar observation. Non-specific bone changes especially fractures and joint subluxation could be an incidental finding and large-scale validation is required to make an accurate interpretation.

We observed both specific and non-specific bone changes to be more common in the upper extremities than in the lower extremities. A similar observation was made by Ranjan Kumar et al [14] and Mohammad et al [4].

We observed prevalence of bone changes among patients with deformities to be 100% (n=23). This is in congruence with the findings of previous investigators who studied leprous bone changes. Since bone changes in turn pave way for deformities, such a high prevalence of radiographic abnormalities among patients with deformities is justified and expected.

On the other hand, 17% patients without any clinical deformities also showed radiographic bone changes in our study.5% patients without any deformities showed specific bone changes of which cortical irregularities/thinning were the most common followed by areas of bone destruction, sclerosis and concentric cortical erosions. Nonspecific bone changes were observed in 9% of patients without deformities of which soft tissue changes, subluxation/dislocation of joints and absorption of phalanges were more commonly observed. Osteoporosis was noted radiographically in 9% of patients without any deformities.

Traditionally X-rays are taken after deformities had developed to know the extent of bone involvement. However, it could be the minute bone changes which start much early before the path to permanent deformity is triggered. Our study findings suggest early X-Rays can help detect these minute changes paving way for early orthopaedic referral, early intensive MDT, preventive rehabilitation (PREHAB) and early physiotherapy.

Conclusion

Our study observed bone changes to be more common among elderly, those with longer disease duration, untreated, defaulted and relapsed cases. Non-specific changes were more common than specific changes. Lepromatous pole showed higher prevalence of bone changes. While all patients with clinical deformities showed radiographic findings, 17% patients without any evidence of deformities exhibited X-Ray abnormalities. Current study thus suggests that judicial use of X-Rays early in the course of leprous pathology can act synergistically with other diagnostic modalities like HPE, nerve USG, NCS, SSS etc. in aiding clinical expertise to achieve disability and handicap prevention.

Ethical Approval: Approval for the study was obtained from Institutional Ethics Committee, Guntur Medical College, Guntur, AP, India.

Consent: Written and informed consent was obtained from all participants of the study.

List of Abbreviations

BT – Borderline-Tuberculoid, BB – Mid-Borderline, BL – Borderline-Lepromatous, LL- Lepromatous PNH – Pure Neuritic Hansen X-Ray – Roentgenogram, USG – Ultrasonogram, SSS – Slit Skin Smear, NCS – Nerve Conduction Study, HPE – Histo Pathological Examination

Authors' Contributions: SG collected, interpreted and prepared manuscript. MR supervised and guided at all stages.HN helped with methodology and final manuscript. All authors read and approved of the final manuscript.

Acknowledgments: The authors would like to thank the Department of Radiology and Department of Pathology, Guntur Medical College for their support throughout the study.

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