Indian J Lepr 2025, 97 : 37-52

http://www.ijl.org.in

Original Article

Bone Changes in Leprosy

R Singh[1], B Dutta[2]

Received: 16.07.2024 Revised: 07.10.2024 Accepted: 07.12.2024

Specific and non-specific changes in the bones have been known for many years. With the availability of early and effective multi-drug treatment, there has been a decline in multibacillary and extensive forms of leprosy, but some patients still bear the brunt of deformities. This study aimed to identify early bone changes in patients even without overt clinical deformities. As studies on cases without overt clinical deformity in recent times are rare, this study has been carried out. A total of 55 patients suffering from leprosy who presented to Dermatology Outpatient Department (OPD) and Upgraded Urban Leprosy Centre attached to Dermatology OPD of Gauhati Medical College were included in this study. Radiological examination was carried out to detect any bone changes in all patients and correlated with clinical findings. Among the 33 patients with bone changes on radiological examination, 36.4% (n=12) patients had specific and 69.7% (n=23) had nonspecific bone changes. Osteoporosis was present in 30.3% (n=10) of patients. Bone changes in skull and paranasal sinuses were found in 21.2% (n=7) of patients. More than one type of bone change was present in many patients involving multiple limbs. In patients without visible deformities, specific bone changes were found in 18.2% of cases, including bone cyst, while nonspecific bone changes were seen in 45.5% (n=5) of cases, including bone spur. Awareness and detection of such changes will enable the clinicians to consider timely measures and prevent their onset and progression.

Keywords: Leprosy, Bone Changes, Specific/Nonspecific, Skull, Paranasal Sinuses, Limbs, India

Introduction

Leprosy remains one of the oldest diseases known to evoke fear and dread among people till date. Despite the declining prevalence rate globally, there were 1, 82, 815 new cases in 2023. India remains the largest contributor, accounting for 58.9% of these cases (WHO 2023a). Social stigma and discrimination associated with leprosy create obstacles to achieving the goal of zero leprosy. Visible deformities are the primary grounds for such social atrocities. These can occur due to direct affliction of peripheral nerves resulting in sensory and motor impairment. Repeated use of an insensitive part can cause secondary deformities, some of these deformities remain permanent (Shah & Shah 2017). Nerve involvement occurs very early, and its effects persist throughout life. Detecting active cases at an early stage and timely intervention can reverse nerve damage and prevent subsequent deformities.

Infiltration of the skin results in a myriad of

[1] Roshni Singh, MD, DNB (Dermatology and Venereology), Department of Dermatology and Venereology, Tinsukia Medical College and Hospital, Tinsukia, Assam, India (Present address)

[2] B Dutta, MD (Dermatology and Venereology), Department of Dermatology and Venereology, Pragjyotishpur Medical College and Hospital, Guwahati, Assam, India (Present address)

Place of Study: Gauhati Medical College, Guwahati, Assam, India

Corresponding author: Dr. Roshni Singh, **Email**: singhdrroshni@gmail.com

cutaneous presentations. These are conspicuous on face and can result in the most stigmatizing deformities if not treated. Loss of eyebrows, sagging and wrinkling of skin, enlarged earlobes, saddle nose and lagophthalmos are the common deformities of the face (Shah & Shah 2017). Disfigurements foster fear of being ostracized; fear begets concealment, which results in delays in diagnosis and treatment. This, in turn, provides space for the development of crippling deformities and lifelong disabilities. Facial bone changes were first described as facies leprosa or Bergen syndrome by Moller-Christensen (1974) and rhino-maxillary syndrome by Andersen & Manchester (1992).

Besides peripheral nerve and skin involvement, bone changes occur in 15-95 % of cases (Thappa et al 1992). Bone involvement is one of the principal prognostic factors (Ankad & Halawar 2015). In addition to their predictive significance, it also served as valuable physical evidence in archaeology, contributing to our understanding of the disease's historical prevalence, impact and role in shaping past societies (Robbins et al 2009). Involvement of bones and their progression towards permanent dysfunction are influenced by a multitude of factors, including demographic variables such as age, sex, occupation, disease characteristics such as duration and type of disease, reactional episodes, neural damage, treatment and psychosocial factors including the attitudes of both the patient and caregiver. The bone changes in leprosy are classified into two major groups: (1) Specific bone changes and (2) Nonspecific bone changes. Direct invasion of *Mycobacterium leprae* causes specific bone changes (Ramesh & Kataria 2017). Bacilli infiltrate the feeding vessels and disseminate via the Haversian canal. The proliferation of endothelial cells in small vessels leads to leprous endarteritis, ultimately resulting in aseptic necrosis of bone. Granulomatous tissue reaction leads to focal areas of rarefaction on radiographs, signifying bone changes. The specific bone lesions in leprosy are usually confined to the small bones of the face, hand and feet (Enna et al 1971, Fite 1941, Skinsnes et al 1972). The common specific bone changes reported are primary periostitis, bone cysts, thinning and irregularities of cortex and honeycombing. These were observed in 14.3–66% of patients (Camacho et al 2011, Chhabriya et al 1985, Kothari et al 2014, Mohammad et al 2016, Paterson 1961, Thappa et al 1992).

Nonspecific bone changes, such as absorption of phalanges, soft tissue changes and flexion deformity were frequently observed in various studies (Camacho et al 2011, Chhabriya et al 1985, Kothari et al 2014, Mohammad et al 2016, Paterson 1961, Thappa et al 1992). Denervation resulting in sensory and/or motor impairment initiates a sequence of events, including repeated trauma, trophic changes, secondary infection and restricted movement. Continuous use of insensitive hands and feet makes the patient liable to repeated injuries and subsequent ulceration, secondary infection, absorption of digits and auto-amputation (Ramesh & Kataria 2017). Absorptive changes of bone usually involve the phalanges of the hands and in the metatarsals of the feet (Cooney & Crosby 1944). Concentric absorption of the bone affects the width, commonly involves proximal phalanges, metatarsal and metacarpals; the distal absorption affects the length. The most frequently combined absorption of both length and width is observed in leprosy. In advanced cases, the bone end may appear tapered, resembling a licked candy stick, and progressive loss of digits may result in mitten hand. Deformity and motor dysfunction can disrupt weight distribution across the foot, causing trauma in areas of maximum pressure, resulting in ulceration, bone resorption and tarsal disintegration (Enna et al 1971, Harris & Brand 1966, Ramesh & Kataria 2017). About 10% of patients with longstanding peripheral

neuropathy in leprosy are at risk of developing neuropathic osteoarthropathy (Charcot's joint) (Messner 1979). Other factors implicated in nonspecific bone changes include disuse atrophy, impaired blood supply and osteoporosis. A disease like leprosy, which has a protracted course, not only induces osteoporosis but also predisposed patients to fractures. Factors responsible for osteoporosis, include nutritional deficiency - calcium and vitamin D deficiency and a low-protein diet, disuse atrophy, testosterone deficiency due to hypogonadism, use of high dose corticosteroid for reactional episodes and an increased production of proinflammatory cytokines like IL 1, 6 and TNF α 1 stimulating osteoclastic activity (Ilias et al 2020, Ishikawa et al 2000, Leal et al 2006, Ramesh & Kataria 2017, Wei et al 2005). Osteoporosis commonly affects the phalanges and metacarpals and may also involve long bones and ribs (Katoch 2001).

India contributes approximately one - fourth (24%) of the global burden of leprosy related deformities (WHO 2023b). The World Health Organization (WHO) classified these deformities as Grade 1 when there is anesthesia and Grade 2 when visible deformities are seen. Leprosy continues to be the leading cause of preventable disability. The timely commencement of multidrug therapy at the early stage can prevent leprosy related deformities (van Brakel et al 2012). However, the bone affection in leprosy can persist for years post-multidrug therapy completion, due to late detection, absence of timely assistance or poor adherence to self-care practices. This necessitates the need for comprehensive care, from providing anti-leprosy treatment to managing the consequences of leprosy. Assessing bone changes in these patients with the aid of clinical and radiological parameters enables early detection and prompt intervention, thereby mitigating the burden of the disease.

While there have been numerous studies on bone changes in patients with obvious deformities in the past, studies on cases without overt clinical deformity are scarce in recent times. Moreover, correlation with the presence of anesthesia, motor weakness, trophic ulcer and other overt deformities with bone changes has become imperative to prevent progression and irreparable damage. This study has been carried out to understand these aspects in the leprosy patients being treated now.

Materials and Methods

A total of 55 patients suffering from leprosy who presented to Dermatology Outpatient Department (OPD) and Upgraded Urban Leprosy Centre attached to Dermatology OPD of Gauhati Medical College were included in this study. Ethical clearance and informed consent were obtained. Data was recorded in a pre-structured proforma, which included detailed history including age, sex, occupation, duration of illness, anesthesia, type of skin lesions, muscle weakness, reactional episodes, deformity and other associated symptoms. A thorough clinical examination and routine investigations were done for each case. Radiological examination was carried out to detect any bone changes in all patients. Various radiological features were correlated with clinical parameters. Data was analyzed using the Statistical package for the Social Sciences (SPSS) version 21. The significance of findings was tested using chi-square test, with a p-value of less than 0.05 was considered significant. Results on continuous measurements are presented on Mean± SD and on categorical measurements are presented in numbers (%). The results have been represented in tabular form and graphically.

Results

Out of 55 patients diagnosed with leprosy, 33 patients (60%) were found to have bone changes on roentgenogram. The mean age of the patients

was 39.79±16.8, with the youngest being 8 years old and the oldest 73 years. Many patients (n=8, 24.2%) were within 46-55 years of age. Males comprised 78.8% (n=26) of cases and females 21.2% (n=7). The male-to-female ratio was 3.7: 1. Bone changes were most observed among laborers (n=9, 27.3%) followed by shopkeepers (n=6, 18.2%) and homemakers (n=5, 15.2%). Nearly half of the cases (48.4%, n=16) have been suffering from disease for the last 1-4 years of duration.

In our cases, we had patients with or without visible disabilities/ deformities. We had a case of pure neural leprosy with autoamputation of left great toe, trophic ulcer on plantar aspect of left 2nd metatarsal head and right calcaneum, clawing of toes & fingers and ulcer present on the palmar aspect of left 2nd proximal interphalangeal joint (PIPJ) (Figs. 1A & 1B).

Among the 33 patients with bone changes on radiological examination, 36.4% (n=12) patients had specific and 69.7% (n=23) had nonspecific bone changes. Osteoporosis was present in 30.3% (n=10) of patients. Bone changes in skull and paranasal sinuses were found in 21.2% (n=7) of patients. More than one type of bone change was present in many patients involving multiple limbs.

Most patients with bone changes had multibacillary types of leprosy. Maximum patients with pure neural leprosy showed bone changes, with 84.6%, (11 out of 13) affected. This was followed by those with borderline lepromatous at 63.2%, (12 out of 19), and both lepromatous and borderline tuberculoid leprosy at 50% each (5 out of 10 for each group). Additionally, patients with pure neural leprosy and lepromatous leprosy presented with all types of bone changes. In this study, more than half of the patients showing bone changes (60.6%, n=20) did not present with any lepra reaction. However, 39.4% (n=13) of cases with bone changes were in lepra reaction,

Fig. 1A & 1B : A case of pure neural leprosy with autoamputation of left great toe, trophic ulcer on plantar aspect of left 2nd metatarsal head and right calceneum, clawing of toes & fingers and ulcer present on the palmar aspect at left 2nd proximal interphalangeal joint (PIPJ).

Table 1 : Specific bone changes involving feet and hands.

Specific bone changes	No. of cases showing bone changes on radiography			Total percentage of patients
	Involving only feet	Involving only hands	Both feet and hands	
Bone cyst	3	1	1	15.2% (n=5)
Areas of destruction	1	-	-	3.03% (n=1)
Cortical thinning & irregularity	3	-	-	9.1% (n=3)
Sclerosis	2	-	-	6.1% (n=2)
Periostitis	-	2	-	6.1%(n=2)
Subarticular erosion	2	-	-	6.1% (n=2)
Destroyed cortical area	2	-	-	6.1% (n=2)

Table 2 : Nonspecific bone changes involving feet and hands (metatarsals are for feet only).

Nonspecific bone changes		Number of cases showing bone changes on radiography			Total percentage of patients
		Involving only feet	Involving only hands	Both feet and hands	
Resorption	Distal phalanges	10	2	-	36.4%(n=12)
	Middle phalanges	2	1	-	9.1% (n=3)
	Proximal phalanges	5	-		15.2%(n=5)
	Metatarsals	3	-	-	9.1% (n=3)
	Total	10	2	-	36.4%(n=12)
Soft tissue changes		9	3	1	39.4%(n=13)
Tuft erosions		1	1	1	9.1% (n=3)
Flexion deformity		4	1	-	15.2% (n=5)
Bone spur		3	1	-	12.1% (n=4)
Subluxation		3	2	-	15.2% (n=5)
Arthritis		2	1	-	9.1% (n=3)
Fracture		2	1	-	9.1% (n=3)
Concentric absorption		3	-	-	9.1% (n=3)
Cupping of joint		2	-	-	6.1% (n=2)
Disintegration of tarsal bones		2	-	-	6.1% (n=2)

Table 3 : Bone changes in skull and paranasal sinuses.

Findings in skull and paranasal sinuses	Number of cases	Percentage (%)
Maxillary antrum opacity	2	6.1%
Frontal sinus changes	2	6.1%
Hypertrophy of inferior turbinate	2	6.1%
Others Periapical cyst (1) Interspinous ligament calcification (1) External occipital protuberance prominence (1)	3	9.1%
Total no. cases with bone changes in skull & paranasal sinuses	7	21.1%

Table 4 : Association of bone changes on radiograph with clinical features.

Clinical features	Total no. of cases with clinical features (out of total no. of patients)	Specific bone changes involving feet & hands	Nonspecific changes involving feet & hands	Osteoporosis	Bone changes in skull & paranasal sinuses
Anesthesia of distal limbs	85.5% (n=47)	23.4% (n=11)	46.8% (n=22)	14.9% (n=7)	14.9%(n=7)
Motor weakness	36.4% (n=20)	40% (n=8)	70% (n=14)	15% (n=3)	35% (n=7)
Trophic ulcer	32.7% (n=18)	50% (n=9)	77.8% (n=14)	22.2% (n=4)	38.9%(n=7)
Clawing of fingers/ toes	23.6% (n=13)	53.8% (n=7)	84.6% (n=11)	7.7% (n=1)	23.1%(n=3)
Shortening of fingers/ toes	18.2% (n=10)	70% (n=7)	100% (n=10)	20% (n=2)	20% (n=2)
Reaction hand	5.5% (n=3)	100% (n=3)	33.3% (n=1)	0	0
Frozen feet	5.5% (n=3)	33.3% (n=1)	100% (n=3)	33.3%(n=1)	66.7% (n=2)
Foot drop	5.5% (n=3)	33.3% (n=1)	66.7% (n=2)	0	0
Leonine facies	5.5% (n=3)	33.3% (n=1)	33.3% (n=1)	100% (n=3)	66.7% (n=2)

Table 5 : Bone changes in patients with and without visible deformities (n=55).

	Bone changes absent	Bone changes present
Patients with deformities	5.5% (n=3)	38.2% (n=21)
Patients without visible deformities	34.5% (n=19)	21.8% (n=12)

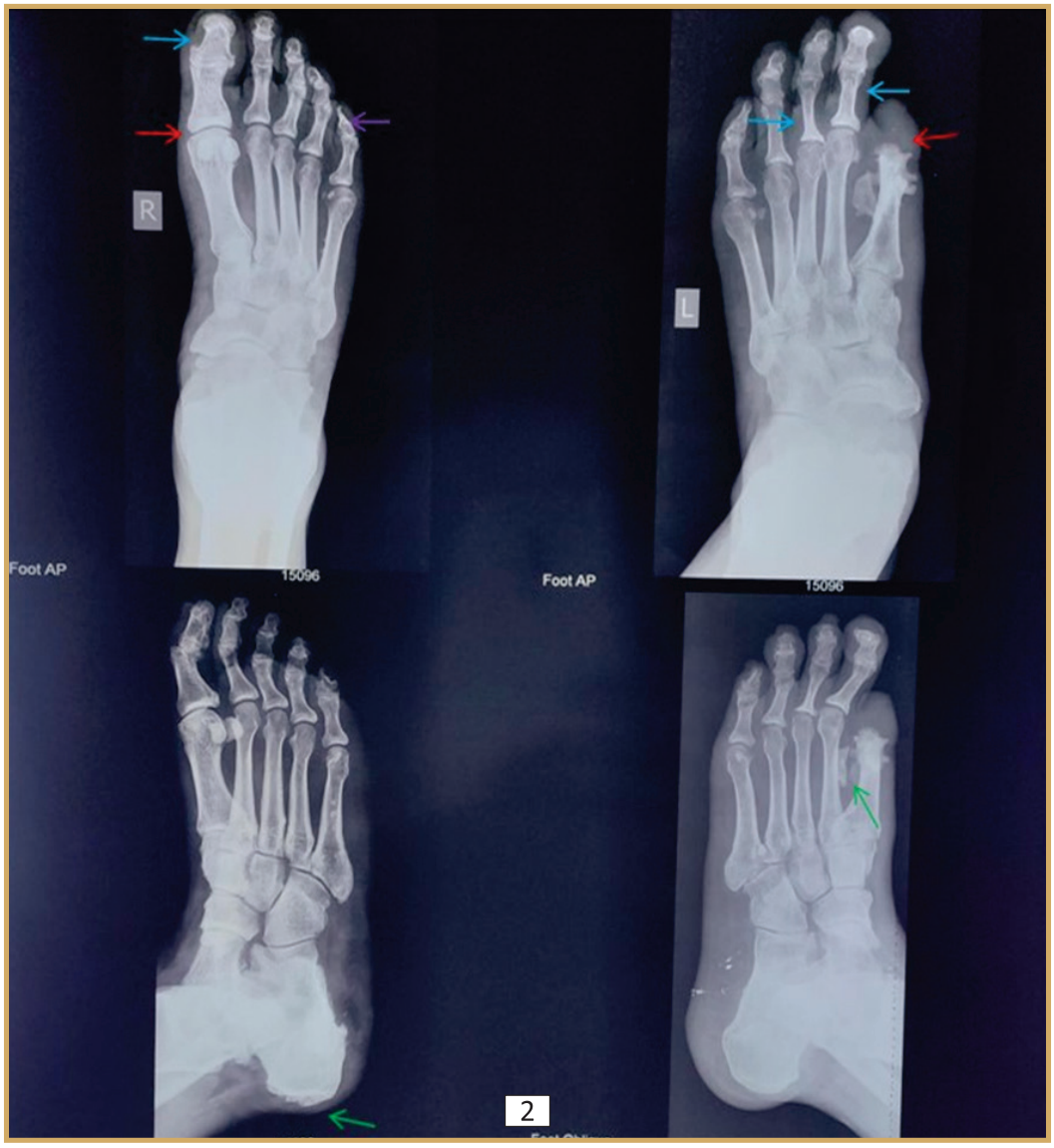

Fig. 2 : X-ray of both feet.

X-ray of Right (R) foot:
Bones are mildly osteopenic

- → 1st IPJ reduced with sclerosis of joint margin & mild subluxation
- → Thinning of shaft of distal phalanx of great toe
- → Cortical irregularity on calceneum
- → Distal phalanx of 5th digit thinned out and candy stick appearance noted

X-ray of Left (L) foot:
Bones are mildly osteopenic

- → Proximal & distal phalanges of great toe are completely resolved with cortical irregularity and sclerosis of 1st metatarsal
- → Bone fragments are present in 1st & 2nd metatarsals
- → Shaft of proximal phalanx of 2nd & 3rd toes are thinned out with sclerosis of cortex

Table 6 : Types of bone changes in patients without visible deformities.

Specific bone changes	Nonspecific bone changes	Osteoporosis	Total number
18.2 % (n=2)	45.5% (n=5)	45.5% (n=5)	12

Fig. 3 : X ray both hands.

→ Bony spurs noted along bilateral terminal phalanges

→ Flexion deformity noted involving bilateral 1st and left 2nd distal interphalangeal joint (DIPJ)

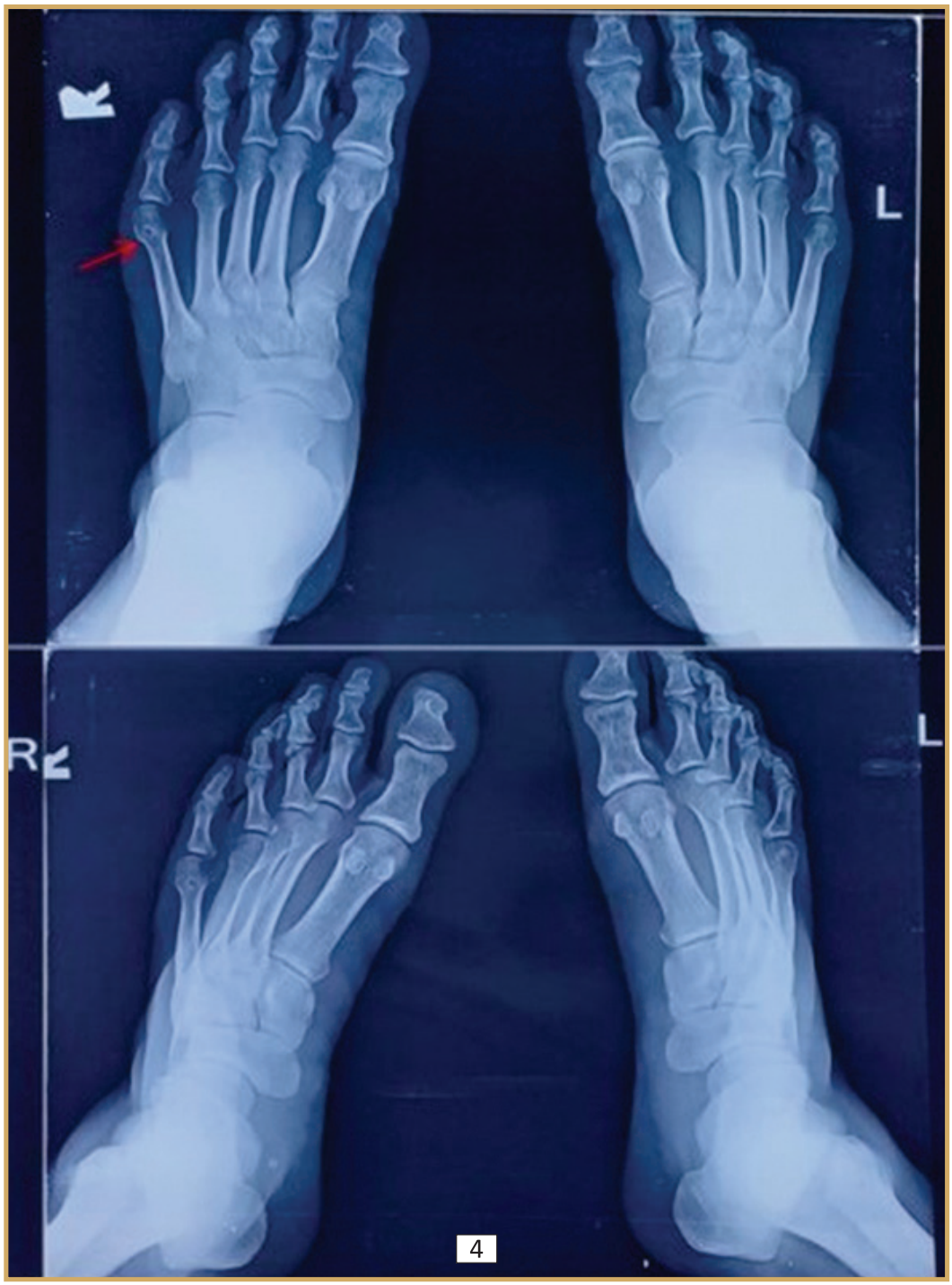

Fig. 4 : X-ray of feet – Small lucency noted in head of 5th metatarsal suggestive of subchondral cyst.

Fig. 5 : X-ray of feet – Calcaneal spur on left foot.

out of these 7 cases were in type 1 lepra reaction and 6 cases were in type 2 lepra reaction.

Various specific bone changes involving feet and hands, along with their frequencies, are shown in Table 1. Bone cyst (15.2%, n=5) and cortical thinning and irregularity (9.1%, n=3) were the common specific bone changes.

The most frequently observed nonspecific bone changes affecting feet and hand were soft tissue changes (39.4%, n=13) and resorption (36.4%, n=12). These changes were more prevalent on feet; however, some patients had both specific and non-specific bone changes, with multiple bones involved. Other findings noted in this study are presented in Table 2. In skull and paranasal sinuses, maxillary antrum opacity, frontal sinus changes and hypertrophy of inferior turbinate were the most observed features (Table 3). These changes in bone were predominantly found in patients with features indicative of sequelae of a longstanding disease. Such associations are depicted in Table 4, the occurrence of such changes was found in association with several forms of deformities (Table 4). In most cases, these clinical features were associated with more than one radiological feature.

Some of the bony changes observed in the patients studied are presented in Figs. 2 to 5. Changes in feet and hands with deformities are visible in Figs. 2 & 3 respectively. On the other hand, changes in patients without deformities/ disabilities are visible in Figs. 4 & 5.

In this study, we observed that some of the patients without visible deformities showed bone changes whereas only a few cases (n=3) with deformities had normal radiographs and these cases had anesthesia with early signs of ulnar nerve involvement (Wartenberg's sign). Observations are tabulated in Table 5 and are statistically significant (p value < 0.01).

Bone changes found in patients without visible deformities are summarized in Table 6 and Fig. 6. In patients without visible deformities, specific bone changes were found in 18.2% of cases, including bone cysts (Fig. 4), while nonspecific bone changes in 45.5% (n=5) of cases, including bone spur (Fig. 5) and soft tissue changes.

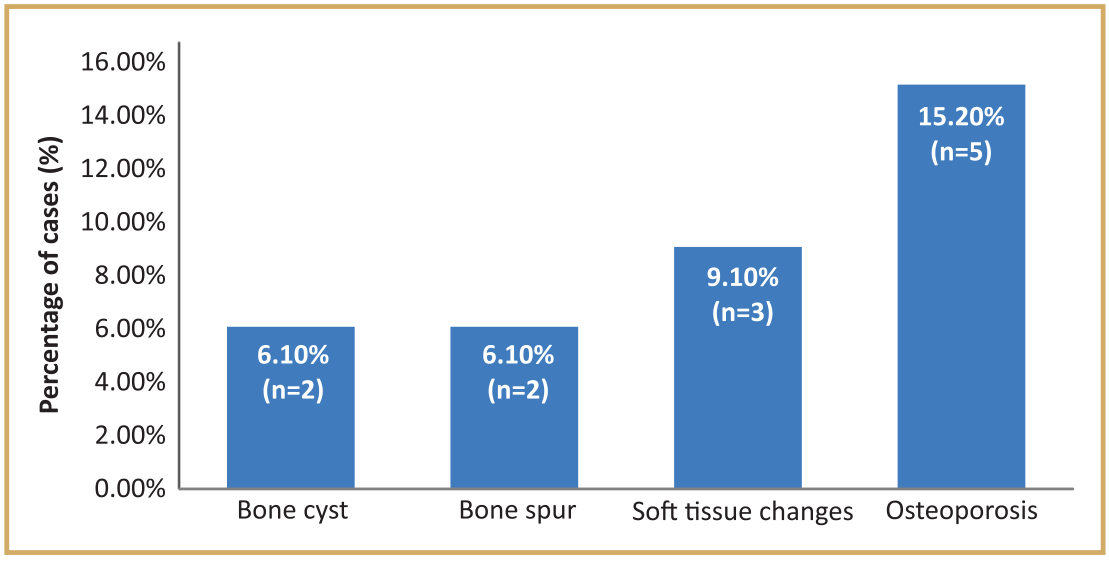

Fig. 6 : Bone changes in patients with no deformity.

Table 7 : Comparison of various specific bone changes in hand and feet in our study with other studies.

Specific bone changes	Chhabriya et al (1985)	Paterson (1961)	Thappa et al (1992)	Choudhuri et al (1999)	Mohammad et al (2016)	Sharma et al (2024)	Present study
Honey-combing	6%	3%	-	-	46%	9.5%	-
Bone cyst	22%	2.8%	10.5%	22.7%	36%	-	15.2%
Thinning and irregularity of cortex	4%	-	-	-	28%	-	9.1%
Areas of destruction	8%	1%	-	-	20%	4.8%	3.03%
Primary periostitis	4%	-	1.3%	28.2%	14%	19.04%	6.1%
Concentric cortical erosion	8%	0.2%	1.3%	10%	10%	-	-
Enlarged nutrient foramen	2%	1.5%	5%	4.5%	6%	-	-
Subarticular erosion	10%	-	10.5%	10%	-	14.3%	6.1%
Sclerosis	14%	4.2%	-	-	16%	9.5%	6.1%
Pseudocyst	-	5%	-	-	-	-	-
Subarticular collapse	-	1.2%	-	-	-	-	-
Cortical area destroyed	-	0.7%	-	-	-	-	6.1%

Additionally, 45.5% of cases showed features suggestive of osteoporosis on radiographs. One patient exhibited both specific and nonspecific bone changes – presenting with a bone cyst and soft tissue changes. Notably, patients with only anesthesia over hands and feet showed all types of bone changes, including skull and paranasal sinuses. These findings strongly suggest that changes in bones can occur in absence of visible deformities. Therefore, inclusion of radiographical screening in all cases of leprosy is imperative to facilitate timely diagnosis and management.

Discussion

Bone changes in leprosy have been extensively studied in the past, but just a few studies have been conducted in recent years. In our study, we observed bone changes in 60% of patients, while earlier studies reported a much higher prevalence, with bone changes noted in 80-100% of their cases (Chhabriya et al 1985,

Table 8 : Comparing various nonspecific bone changes in hands and feet in the present study and other studies.

Specific bone changes		Chhabriya et al (1985)	Thappa et al (1992)	Choudhuri et al (1999)	Ankad et al (2011)	Moham-mad et al (2016)	Sharma et al (2024)	Present study
Resorp-tion	Distal phalanges	84%	59.2%	48.2%	96%	40%	19.04%	36.4%
	Middle phalanges	72%	34.2%	27.2%	60%	32%	-	9.1%
	Proximal phalanges	60%	19.7%	13.6%	40%	18%	-	15.2%
	Metatarsals	22%	10.5%	10.9%	28%	2%	-	9.1%
	Metacarpals	-	-	-	4%	-	-	-
Soft tissue changes		74%	39.5%	44.5%	44.5%	16%	9.5%	39.4%
Tuft erosion		56%	15.8%	13.6%	86%	32%	-	15.2%
Flexion deformity		38%	36.8%	22.7%	58%	64%	14.3%	15.2%
Bone spur		-	-	-	-	-	-	12.1%
Subluxation		28%	10.5%	18.2%	30%	32%	14.3%	15.2%
Arthritis		10%	14.5%	26.4%	36%	18%	-	9.1%
Fractures		4%	6.6%	3.6%	12%	4%	-	9.1%
Concentric absorption		68%	39.5%	32.7%	6%	32%	-	9.1%
Cupping of joints		6%	7.9%	6.4%	12%	22%	-	6.1%
Disintegration of tarsal bones		-	1.3%	1.8%	12%	8%	-	6.1%

Paterson 1961, Thappa et al 1992, Ankad et al 2011, Camacho et al 2011, Kothari et al 2014, Mohammad et al 2016). However, Sharma et al (2024) reported bone changes in 42% of cases. Specific bone changes in hands and feet were seen in 36.4% (n=12) of patients while non-specific bone changes in hands and feet were present in 69.7% (n=23) of patients. Osteoporosis and bone changes in skull & paranasal sinuses were found in 30.3% (n=10) and 21.2% (n=7) of the study group respectively. Several types of bone changes observed in this study are compared with results of various studies in Tables 7 and 8.

The incidences of bone changes were higher in earlier studies. These studies have included patients with deformities and bone changes are more likely to occur in such cases. Moreover, implementation of strategies for early diagnosis, availability of multidrug therapy and leprosy control programs have led to decrease in the total number of cases, as reflected in this study.

In our study, bone spur was noted in 12.1% (n=4) of the patients. Among these patients, one had an active trophic ulcer and other had evidence of healed trophic ulcer. This finding was not observed in previous studies. However, bone spur was reported in 3% of patients in a study of plantar ulcers by Subramoniam & Parapattu (2017). Bone spur can be found in cases of

recurrent or persistent heel ulcer. They may exert constant pressure or cause the rupture of an unyielding scar under shear stress, which could continue the process of ulceration (Lennox 1964). The incidental finding of a bone spur should encourage more preventive measures in an anaesthetic foot.

The changes observed in the skull and paranasal sinuses in this study were maxillary antrum opacity, frontal sinus changes and hypertrophy of inferior turbinate. Similar findings have been documented by Chhabriya et al (1985), Camacho et al (2011) and Mohammad et al (2016). The nasal and paranasal sinuses were reported as the most affected system in a study conducted in Eastern India. The nose acts as the main portal of entry for *Mycobacterium leprae*, which can result in edema and thickening of the mucosal lining in the inferior turbinate and nasal septum (Panda et al 2017). Features such as periapical cyst, external occipital protuberance prominence and interspinous ligament calcification were identified in this study but were not observed in previous studies. Periapical cyst could develop secondary to chronic periapical periodontitis or periapical granuloma, resulting from bacillary infiltration (Nunez–Marti et al 2004 and Vohra et al 2019). Further, histological and serological test could confirm the presence of leprae bacilli. Prominence of external occipital protuberance and interspinous ligament calcification could be incidental findings.

In accordance with other studies, most patients with bone changes in this study were males aged 26 – 55 years and they were predominantly labourers. The higher incidence in this group could be attributed to the increased risk of exposure to disease, repeated trauma from outdoor occupations and lack of appropriate care and knowledge. Most cases with a long duration of the disease showed changes in their bones, indicating that the chronicity of the disease increases the risk of bone involvement, as also found in other studies (Paterson 1961, Ishikawa et al 2000, Ankad et al 2011, Mohammad et al 2016). The maximum number of patients with bone changes in our study had multibacillary type of leprosy and most of them were not in reaction. Similar observations were made by Thappa et al (1992), Chhabriya et al (1985) and Mohammad et al (2016).

Most bone changes are the consequence of inappropriate care of primary impairment rather than disease itself, thus they can be prevented. Osteoperiostitis, which often occurs during reactional episodes, commonly affects the phalanges (Leprous dactylitis) and the tibia. Without proper treatment, it can lead to osteoporosis, resorption of distal phalanges and subcortical osteolysis in the small bones of hand and thickening of the tibial bones. Trophic ulcers on the hands and feet can cause bone destruction, which may eventually result in secondary deformities (Katoch 2001). Several deformities such as wrist drop/foot drop, amputation of fingers/toes, trophic ulcer, resorption of fingers/toes, anaesthesia of distal limbs, motor weakness and clawing of finger/toes associated with bone changes were documented in earlier studies (Paterson 1961, Thappa et al 1992, Mohammad et al 2016). However, these associations with specific bone changes were observed in lesser number of patients in this study (Table 4). The early initiation of multidrug therapy in these cases in present study might have accounted for decline in instances of such associations. On the contrary, frequencies of such associations remained the same with nonspecific bone changes. This reflects that the burden of deformities continues to persist in society and demands for more proactive measures and individualized care.

In this study, a noteworthy observation was made that changes in bone can occur in patients

even without any visible deformities (Table 6, Fig. 6). These changes included bone cysts, calcaneal spur and osteoporosis. If left untreated, these cases may develop irreversible changes in bones, which probably account for the maximum disability and deformity. Therefore, early radiological examination could help in formulating a plan for early management and preventing the permanent loss of function and development of deformities.

Early detection of bone changes in cases with sub-clinical evidence of deformity, appropriate counseling and management of patients with both occult and overt deformities and ensuring regular follow-up and care of this group of patients will go a long way in achieving the goal of Global Leprosy Strategy 2021-2030 (WHO 2021). This strategy aims at a 90% reduction in the rate per million populations of new cases with grade 2 disability. To the best of our knowledge, we are the first to report such findings about bony changes in leprosy patients in recent years.

Acknowledgements

The authors would like to thank Dr. Vishnu S (MD, DNB, Radiology) and Dr. Roshan Kumar (MS, Orthopaedics) for helping us to interpret the radiographs of our patients.

References

1. Andersen JG, Manchester K (1992). The rhinomaxillary syndrome in leprosy: a clinical, radiological and palaeopathological study. *Int J Osteoarchaeol***. 2(2)**: 121-129.
2. Ankad BS, Halawar RS (2015). Bone involvement in leprosy: Early changes. *Radiol Infect Dis.* **1(2)**: 88-89.
3. Ankad BS, Hombal A, Sudhakar R et al (2011). Radiological changes in the hands and feet of leprosy patients with deformities. *J Clin Diagnostic Res*. **5(4)**: 703–707.
4. Camacho ID, Burdick A, Benjamin L et al (2011). Chronic rhinitis: a manifestation of leprosy. *Ear, Nose Throat J*. **90(9)**: E1-E3.
5. Chhabriya BD, Sharma NC, Bansal NK et al (1985). Bone changes in leprosy. A study of 50 cases. *Indian J Lepr*. **57(3)**: 632-639.
6. Choudhuri H, Thappa DM, Kumar RH et al (1999). Bone changes in leprosy patients with disabilities/ deformities (a clinico-radiological correlation). *Indian J Lepr*. **71(2)**: 203-215.
7. Cooney JP, Crosby EH (1944). Absorptive bone changes in leprosy. *Radiology*. **42(1)**: 14-19.
8. Enna CD, Jacobson RR, Rausch RO et al (1971). Bone changes in leprosy: a correlation of clinical and radiographic features. *Radiology*. **100(2):** 295-306.
9. Fite GL (1941). The vascular lesions of leprosy. *Int. J. Lepr*. **9**: 193-202.
10. Harris JR, Brand PW (1966). Patterns of disintegration of the tarsus in the anaesthetic foot. *J Bone Joint Surg*. *Br*. **48(1)**: 4-16.
11. Ilias I, Milionis C, Zoumakis E (2000). Updated 2022 March 19. An overview of glucocorticoid induced osteoporosis. In: Endotext (Feingold KR, Anawalt B, Blackman MR, et al Eds) MDText.com; Inc., South Dartmouth (MA).
12. Ishikawa S, Mizushima M, Furuta M et al (2000). Leydig cell hyperplasia and the maintenance of bone volume: bone histomorphometry and testicular histopathology in 29 male leprosy autopsy cases. *Int J Lepr other Mycobact Dis*. **68(3):** 258–266.
13. Katoch K (2001). Leprosy: Systemic aspects. In: IADVL Textbook and Atlas of Dermatology, 2nd edition, Vol 2. Bhalani Publishing House, Bombay (Mumbai), India, pp1604-1612.
14. Kothari SY, Kumar W, Swamy MK et al (2014). Deformities and bone changes in leprosy. IJOPMR. 25(1):13-17. DOI: 10.5005/IJOPMR-25-1-13.
15. Leal ÂM, Magalhães PK, Souza CS et al (2006). Pituitary–gonadal hormones and interleukin patterns in leprosy. *Trop Med Int Health*. **11(9)**: 1416-1421.
16. Lennox WM (1964). A classification of leprosy foot deformities. *Lepr Rev*. **35**: 245-249.
17. Messner RP (1979). Arthritis due to mycobacteria and fungi. In: Arthritis and allied conditions (Daniel J McCarthy, Ed), Lea & Febiger, Philadelphia, PA, pp1380–1384.

18. Mohammad W, Malhotra SK, Garg PK (2016). Clinico-radiological correlation of bone changes in leprosy patients presenting with disabilities/ deformities. *Indian J Lepr*. **88 (2)**: 83-95.
19. Moller-Christensen V (1974). Changes in the anterior nasal spine and the alveolar process of the macillae in leprosy a clinical examination. *Int J Lepr other Mycobact Dis*. **42(4**): 431-435.
20. Núñez-Martí JM, Bagán JV, Scully C et al (2004). Leprosy: dental and periodontal status of the anterior maxilla in 76 patients. *Oral Dis*. **10(1**): 19-21.
21. Panda JK, Nayak M, Rout AN et al (2017). Systemic manifestation of leprosy: a comprehensive epidemiological study from eastern India. *J Med Sci Clin Res*. **5:** 26-34.
22. Paterson DE (1961). Bone changes in leprosy. Their incidence, progress, prevention and arrest. *Int J Lepr*. **29(4**): 393-422.
23. Ramesh V, Kataria JK (2017). Systemic involvement in leprosy. In: IAL Textbook of Leprosy, (Bhushan Kumar, Hemant Kumar Kar, Eds) 2nd edition, Jaypee Brothers Medical Publishers (P) Ltd. pp332- 340.
24. Robbins G, Tripathy VM, Misra VN et al (2009). Ancient skeletal evidence for leprosy in India (2000 B.C.). *PLoS One*. **4(5**): e5669.
25. Shah A, Shah N (2017). Deformities of face, hands, feet and ulcers and their management. In: IAL Textbook of Leprosy, 2nd edition (Bhushan Kumar, Hemant Kumar Kar, Eds). Jaypee Brothers Medical Publishers (P) Ltd, pp518-528.
26. Sharma S, Malgotra V, Wani M (2024). Radiological changes in leprosy patients with disabilities and deformities of hands and feet. *Scr Med*. **55(3**): 385-390.
27. Skinsnes OK, Sakurai I, Aquino TI (1972). Pathogenesis of extremity deformity in leprosy. *Int J Lepr*. **40**: 375-388.
28. Subramoniam L, Parapattu B (2017). A clinical study of plantar ulcers in leprosy. *J Evid Based Med. Health*[on-line]. **4(48**): 2904-2907.
29. Thappa DM, Sharma VK, Kaur S et al (1992). Radiological changes in hands and feet in disabled leprosy patients: a clinico-radiological correlation. *Indian J Lep*. **64(1**): 58-66.
30. van Brakel WH, Sihombing B, Djarir H et al (2012). Disability in people affected by leprosy: the role of impairment, activity, social participation, stigma and discrimination. *Global Health Action*. **5(1):** 18394.
31. Vohra P, Rahman MS, Subhada B et al (2019). Oral manifestation in leprosy: A cross-sectional study of 100 cases with literature review. *J Family Med Primary Care*. **8(11**): 3689-3694.
32. Wei S, Kitaura H, Zhou P et al (2005). IL-1 mediates TNF induced osteoclastogenesis. *J Clin Investig*. **115(2)**: 282-290.
33. World Health Organization (2021). Towards zero leprosy. Global leprosy (Hansen's Disease) strategy 2021-2030, (EA Cooreman/Leprosy, Eds). WHO SEARO Regional Office Southeast Asia (RGO), WHO South-east Asia. www.who.int.
34. World Health Organization (2023a). Leprosy – Number of new leprosy cases. Available from: *Number of new leprosy cases* (who.int).
35. World Health Organization (2023b). Leprosy – Number of new leprosy cases with G2D. Available from: *Leprosy - Number of new leprosy cases with G2D* (who.int).

How to cite this article : Singh R, Dutta B (2025). Bone Changes in Leprosy. *Indian J Lepr.* **97**: 37-52.