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Role of high resolution ultrasound in leprosy

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Abstract

Background- Ultrasonography is a safe and cost-effective modality to assess gross morphological changes in nerves non-invasively. Early diagnosis will allow the early institution of therapy and arrest the progression of the disease thus, helping in decreasing disability grading.

Aims and Objectives-• To study the clinical spectrum of leprosy patient. • To assess the peripheral nerves clinically by palpation and then by high resolution ultrasonography and color doppler. • To correlate the ultrasonography findings with clinical findings

Materials and Method-This is a hospital based prospective study done on 30 newly diagnosed and untreated cases of leprosy patients attending Departmentof Dermatology, SCL Hospital, referred for USG of peripheral nerve to the Department of Radio Diagnosis. HRUS was performed on the bilateral ulnar nerve (UN), median nerve (MN), radial nerve (RN), lateral popliteal (LPN) nerve, and posterior tibial nerve (PTN) to see the following parameters: Nerve thickening, echogenicity, color flow, and abscess.

Result– The ulnar nerve was most frequently involved. Diagnostic performance of HRUS for echogenicity was good with sensitivity, positive predictive valueand specificitywas observed as 72.7%, 72.7%, and 62.5%, respectively.

Conclusion- HRUS has several benefits in leprosy scanning; it is a reliable and non-invasive method of assessing alternations in the nerve at sites that may be difficult to be biopsied for histology.

Keywords: Ultrasonography, leprosy, diagnosis, HRUS

Introduction

Leprosy, or Hansen's disease, is a chronic bacterial infection caused by Mycobacterium leprae [1]. M. leprae, the taxonomic order Actinomycetales, family Mycobacteriaceae, is an acid-fast, gram-positive obligate intracellular bacillus that demonstrates tropism for phagocytes in the skin and Schwann cells within peripheral nerves [2]. Leprosy affects skin and nerves mostly. It can affect any system in the body except brain and spinal cord. Mycobacterium leprae is the only bacterium known to affect myelination and cause peripheral neuropathy. Nerve damage affects mainly the ulnar, median, lateral popliteal and posterior tibial nerves resulting in characteristic nerve enlargement. Normally, assessment of nerve thickening is done clinically which is very subjective. Physical examination does not identify the early stages of the disease when clinical manifestations are rare [3, 4]. High resolution ultrasound (HRUS) has shown a number of changes, including increased vascularity, distorted echotexture and enlargement of nerves [5, 6]. Ultrasonography of the peripheral nerves in leprosy to measure the extent of peripheral nerve thickening is a low-cost, non-invasive technology [7]. Efforts to diagnose early or subclinical neuritis could ameliorate the nerve damage which leads to functional impairment of limbs, ulcer formation and stigmatizing deformities. Early detection of nerve involvement at the time of diagnosis or during a leprosy reaction is important so that adequate treatment can be started and further nerve function impairment can be prevented.

Special features of nerve damage in Leprosy

- Central Nervous System is unaffected.
- Sensory fiber involvement is a key feature.
- Thickening is maximum at superficial location.
- Interfascicular plexus aids in nerve damage.

Thickening of peripheral nerves are also seen in persons with heavy manual work and generalized muscular built such as wrestlers and weight lifters. Leprosy is also called Hansen disease (HD).

High-resolution ultrasonography (HRUS) in diagnosing leprosy

HRUS is non-invasive and can be used to evaluate structural alterations in nerves which are difficult for biopsy for histopathology. It is non-invasive and cost-effective in comparison with MRI of nerves, its wider availability, higher soft-tissue resolution, real-time and dynamic imaging, maneuverability to examine the length of the nerve, and pinpoint the precise location of a nerve lesion make it a preferred option in leprosy [8]. The usefulness of HRUS is becoming more recurrent in the differentials of peripheral neuropathy. HRUS is a method for examining soft tissues in static and dynamic states, like blood flow, in real-time. This technique can essentially portray all nerves in the extremities in superb detail due to its enhanced contrast and spatial resolution, which is notably useful in the case of leprosy.HRUS can become a standard technique to augment the clinical diagnosis of leprosy as technological advances lead to greater picture quality, handy ultrasonographic equipment, and economical costs.The use of color Doppler (CD) in addition enables the visualization

of vascular channels and blood flow signals within the nerve [9].

Since nerve enlargement and inflammation are central tenets of leprosy, this study was designed to assess peripheral nerve damage in leprosy patients by HRUS and also to establish HRUS as an initial and helpful aid for the diagnosis of leprosy.

HRUS is a sensitive, cost-effective, non-invasive, and rapid imaging tool to obtain a clear morphological overview of nerves. It is readily available, well accepted by patients, and provides a dynamic evaluation in real-time. MRI is a time-consuming, costly investigation with limited expertise and is not widely available. HRUS in expert hands provides high accuracy and specificity. Our study aims to assess the role of HRUS in leprosy.

Materials and Methods

This is a hospital based prospective study done on 30 newly diagnosed and untreated cases of leprosy patients, referred for USG of peripheral nerve to the Department of Radio Diagnosis, after obtaining approval from the institutional ethical committee. Thestudy period was august 2020 to December 2022. Initially patient details, clinical history and family history were recorded. USG of nerve was done for all patients.

Inclusion Criteria

a. All newly diagnosed Leprosy patients with or without neuritis.
b. Who are willing to co-operate for the study

Exclusion Criteria

a. Patients less than 10 years.
b. Lost to follow up.

Around 30 newly diagnosed leprosy patients were selected from the patients attending Department of Dermatology, SCL Hospital. All patients were explained about the nature of study. Informed written consent was obtained from all patients before initiation of the study. Detailed history along with demographic details such as age, sex, occupation was obtained and patients were evaluated as follows

- General and systemic examination.
- Dermatological examination.
- Systematic and complete examination of thickening of nerves, sensory and motor examination related to ulnar, radial cutaneous, median, lateral popliteal and posterior tibialnerves. Bilaterally, the ulnar nerve at the elbow and proximal to themedial epicondyle, the radial cutaneous nerve at wrist, the median nerve at the wrist, Lateral Popliteal nerve at the fibular head and Posterior tibial nerve at the ankle and proximal to the medial malleolus were examined and the length of abnormality of the nerve was determined by the presence of abnormal size and echo reflectivity of the nerves. All nerves were measured on transverse sections at a point where the nerve thickness is maximum in the visualized segment of the nerve.

In our study out of 300 nerve examination of 30 patients 56 nerves found clinically thickened and 77 nerves thickened on HRUS.

In our study, usefulness of ultrasound as an essential component in detecting nerve damage has been stated. It helps in clinical and therapeutic management of reactions. Ulnar nerve was most frequently involved and showed more changes of the disease. To conclude there was a statistically significant correlation between clinical findings of nerve assessed and sonographic measurement such as echotexture of the nerve and vascularity on Colour Doppler.

Discussion

Peripheral nerve is composed of two cellular elements– Neuron and Schwann cell. Neurons are the structural and functional unit of the peripheral nerve [10]. It contains a cell body, dendrites and an axon. Axon is unbranched for a long length and branches at the end of its process. Multiple axons are grouped together to form a nerve fascicle. Many fascicles are grouped into peripheral nerve.

Study was carried out with the view of assessment of peripheral nerves with HRUS and colour Doppler. Clinical examination of peripheral nerves is very subjective and has inter-observer variation. In order to determine the thickness of nerve precisely ultrasonography has been used. In our study 30 leprosy patients were selected. other causesof peripheral neuropathywereruledout.

Table 1: Comparison of loss of sensation in total patients in leprosy study

Our study (n=30)	**20**
Jain *et al*	36
Bathala *et al*.	68

In our study, on clinical examination of 30patients, 20 patients (67%) presented with loss of sensation. In Jain *et al*. [11] study, 12patients showed sensory loss, 15 patients showed motor weakness and 9 patients showed both sensory and motor weakness. In Bathala *et al*. [12] study of ulnar neuropathy in Hansen Disease, 32 ulnar nerves (76%) showed motor deficits,18 nerves (43%) showed sensory loss, 18nerves showed both motor weakness and sensory loss and 10 nerves did not show any sensory motor abnormalities.

Table 2: Comparison of hrus findings inleprosystudy

Nerve findings	**Our study**	**Jain *et al***
Normo-genic	23	76
Some hypo-echogenicity	14	25
Obvious hypo-echogenicity	32	45
Loss of fascicular pattern	08	06

In our study, on sonographic examination, 23 (30%) nerves were Normogenic and 14 (18%) nerve showed some hypo-echogenicity, 32(42%) of them showed obvious Hypo echogenicity and 08 (10%) nerve showed loss of fascicular pattern. Among all nerves examined in our study, ulnar nerve showed more echo textural abnormality; whereas Jain endotracheal tube noted. al. Observed 76 nerves (50%) were normo-genic and 77(50%) were hypoechoic. Out of which 25 (16.4%) nerves were mild hypoechoic, 45(29.7%) were moderately hypoechoic and 6 (3.9%) showed fascicular pattern loss.

Table 3: Comparison of total nerve thickened and hrus nerve enlargment in leprosystudy

+	**Our study**	**Renu venugopal *et al***	**Ms kumaran *et al***
Total nerve examined	300	320	240
Clinically thickened	56	71	130
Hrus enlargment	77	63	110

In our study out of 300 nerve examination of 30 patients were done,among them 56 nerves found clinically thickened and 77 nerves thickened on HRUS. In Renu Venugopal *et al* [13] out of 320 nerve examination 71 nerves found clinically thickened and 63 nerves thickened on HRUS. In MS Kumaran *et al*. [14] out of 240 nerve examination 130 nerves found clinically thickened and 110 nerves thickened on HRUS.

Table 4: Enlargment of nerve on hrus

NERVE	RT	LT	TOTAL
UN	24	16	40
RCN	3	5	8
MN	0	0	0
LPN	11	12	23
PTN	4	2	6
TOTAL	42	35	77

In our study found that on HRUS the most frequently involved nerve is ulnar nerve, while the median nerve is the least involved.

In our study, usefulness of ultrasound as an essential component in detecting nerve damage has been stated. It helps in clinical and therapeutic management of reactions. Ulnar nerve was most frequently involved and showed more changes of the disease. To conclude there was a statistically significant correlation between clinical findings of nerve assessed and sonographic measurement such as echotexture of the nerve and vascularity on Colour Doppler.

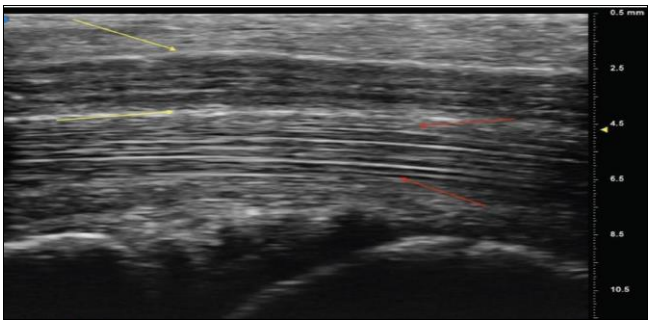

Fig 1:

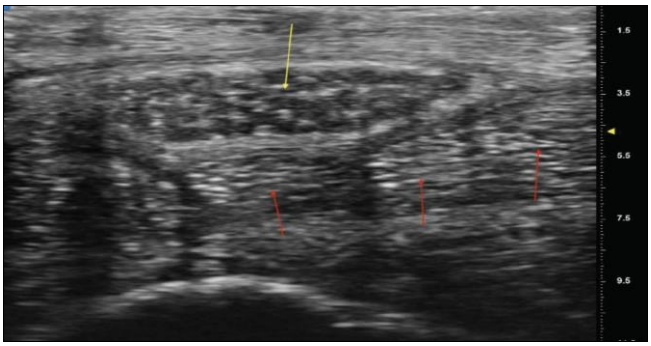

Fig 2:

HRUS of peripheral nerve and tendon. (A) The long-axis view of the nerve (between the yellow arrows) displays the large hypoechoic fascicles. The tendon (between the red arrows) displays the intercalated fibrillar pattern. (B) The short-axis view of the nerve (yellow arrow) and tendons (red arrows). The cross section of the fascicular pattern has the appearance of a honeycomb. The cross section of the finer fibrillar pattern appears like the cut end of a broom.

Result

- On clinical examination of 30 patients included in this study, 20 patients presented with loss of sensation. Ten patients didn't have any sensation loss.
- Out of 300 nerves examined of 30 patients, 22 nerves showed blood flow in colour Doppler.
- Out of 300 nerves examined of 30 patients, 56 were clinically thickened and 77were thickened on HRUS. ¬ Out of 30 patient,14 patients (47%) found to be paucibacillary and 16 patient (53%) found to be multibacillary.
- On final diagnosis most of the patients belonged to Borderline borderline (BB) and Lepromatous leprosy (LL)
- Male were commonly involved as compared to female.
- Most common age group involved 20-25year.
- Majority of the patients had more than one nerve involvement.
- The ulnar nerve was most frequently involved.

Conclusion

High resolution sonography of nerves is superior than clinical palpation of nerves with lesser interobserver variability. The nerves located deeper can be assessed which was not made out on clinical palpation.

HRUS provides an objective way of measuring structural changes of the nerve and its damage. It also assesses the tissues surrounding the peripheral nerve.

It helps in locating nerve abscess along the course of nerve and guides to drain it

HRUS examination has many advantages in imaging the peripheral nerves of leprosy. HRUS is an excellent and cost-effective modality for imaging peripheral nerve and with newer high frequency probes. High resolution Imaging can be an important tool in classification of disease and management of leprosy neuropathy. Early detection of nerve thickening, nerve change and vascularity will aid in early detection of nerve changes, give important information about neuritis which will eventually help in better disease management and disability prevention.

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