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Original Article

The Effectiveness of Early Investigative Tools for Neural Lesions in Leprosy: An Observational Cohort Study

LHV Cegana[1], SMT Nardi[2], L Pascoeto[3], VDA Paschoal[4]

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Leprosy can cause different lesions in peripheral nerves and inervatory structures. This study aims to analyze the effectiveness of evaluation protocols used to identify neural lesions in leprosy, such as Degree of Physical Disability (DPD), Simplified Neurological Assessment (SNA) and propose to use Neuro Dynamic Assessment (NDA). A descriptive analytical study was carried out in 27 individuals treated in two outpatient leprosy clinics in São Paulo State, between 2017 and 2019. A control group of age and sex matched 27 people, chosen from the population without a diagnosis of leprosy, was also evaluated. The Mann-Whitney, Multivariate Linear Regression, association between variables, and $P<0.05$ values were used. The test that most captured the neurological alterations was the SNA, with 22 (81.5%) in the upper limbs (ULs) and 25 (92.6%) in the lower limbs (LLs), followed by the NDA, with 20 (74.1%) in the ULs and 11 (40.7%) in the LLs. The DPD showed handicap in the hands of 16 (59.2%) individuals and in the feet of 17 (62.9%) individuals. The three assessment instruments can and should be used in combination to expand the monitoring of neural lesions in leprosy, as there are changes that are not perceptible with one instrument but can be confirmed by another. If there is an instrument to be chosen, it should be the SNA, because it identifies subtle changes that suggest neural distress.

Keywords : Neural Mobilization, Leprosy, Peripheral Nerves, Disability, Physical Therapy

Introduction

Among infectious diseases, leprosy is considered one of the leading causes of physical disabilities due to its potential to cause neural injuries (Brazilian Ministry of Health 2013). Worldwide, 208,619 new cases of the disease were reported to the World Health Organization (WHO) in 2018, 30,957 occurred in the Americas region and 28,660 (92.6% of the total from the Americas) were reported in Brazil. New cases, which were assessed for their Degree of Physical Disability (DPD), totalled 86.5% (n=24,780); 2,109 (8.5%) had visible physical deformities (DPD2) (Brazilian Ministry of Health 2020).

[1] LHV Cegana, Department of Physical Therapy and Public Health, Municipal Health Office, Public Service, Votuporanga, São Paulo, Brazil.

[2] SMT Nardi, Department of Biomedical Sciences, Adolfo Lutz Institute, Health Center, São José do Rio Preto, São Paulo, Brazil.

[3] L Pascoeto, Department of Physical Therapy and Public Health, Specialized Physical Rehabilitation Center–CERII, Public Service, São José do Rio Preto, São Paulo, Brazil.

[4] VDA Paschoal, Department of Nursing and Public Health, Medical School of São José do Rio Preto – FAMERP, Medical School, São José do Rio Preto, São Paulo, Brazil.

Corresponding Author : LHV Cegana, **Email :** lucegana@gmail.com

The lack of new diagnostic tools and new drugs, limited knowledge about strategic areas of transmission and unsatisfactory tools for managing the complications caused by leprosy have been an obstacle to its control. Therefore, more coordinated research efforts are still needed (WHO 2016).

The diagnosis of leprosy is based on the presence of at least one of three cardinal signs:

a) lesion(s) and/or area(s) of the skin with changes in thermal and/or pain and/or tactile sensitivity; or
b) thickening of the nerve trunks of the peripheral nerves in the upper and lower limbs, associated with sensitivity and/or motor changes in extremities, with decreased muscle strength in the myotomes supplied by these and/or autonomic nerves;
c) presence of *Mycobacterium leprae* bacilli, confirmed by intradermal smear microscopy or skin biopsy (WHO 2018).

Sometimes neurological involvement is preponderant when compared to a dermatological conditions not very significant (Freitas et al 2019). The most affected nerves are the ulnar in the elbow and the fibular in the head of the fibula, followed by the ulnar sensory, superficial and sural fibular branches (Santos et al 2017). Greater occurrence of sensory changes over motor changes is found, as well as a slight presence of deformities (Brazilian Ministry of Health 2016). The sensory and motor actions of *M. leprae* in the ULs and LLs cause secondary injuries such as fingers (Carter & Weiss 2015) and toes in flexion and" fallen hands and foot" (Karmakar & Joshua 2015, Rohatgi et al 2016).

It is essential to assess the integrity of neural function at the time of diagnosis, in the occurrence of reactive states, at discharge due to cure (end of multidrug therapy) and during 5 years after discharge (Brazilian Ministry of Health 2016, Junior et al 2015).

Peripheral neuropathies in leprosy are a triggering factor for physical disabilities, and some evaluation protocols can be used for their prevention, such as the DPD of the WHO and the Simplified Neurological Assessment (SNA) of the Brazilian Ministry of Health (Brazilian Ministry of Health 2016), these routine protocols are subjective (Brazilian Ministry of Health 2016), and other tests could complement the diagnostic examination of peripheral neuropathy such as the Neuro Dynamic Assessment (NDA).

NDA is used for injury diagnosis and treatment of the peripheral nervous system (PNS) and the structures innervated by it; the interface between the musculoskeletal system and the PNS is used, so the movements applied to the musculoskeletal system mobilize the structures of the PNS (Shacklock 1995). Neural mobilization is effective in improving nerve function in leprosy patients (Shah et al 2020). We suggest using the mobilization of the nervous system in clinical practice as a tool to assess peripheral nerves that may be affected by leprosy (Scheibe et al 2012).

This study aims at analyzing the effectiveness of the evaluation protocols used to identify neural lesions in leprosy, such as the DPD, the SNA and propose to use the NDA; and to describing the socio-demographic and clinical variables of the groups studied and check whether there is a statistical association between the results of the evaluation tools: the DPD, SNA and NDA in individuals who have or had leprosy, in addition to determining the specificity and sensitivity of each of the assessment protocols.

Methods

Associative, analytical, descriptive research, following case-control design was approved by the FAMERP Ethics and Research Committee in

accordance with the requirements of National Resolution No. 196/96, Opinion No. 2,469,355. Participants were asked to sign the Informed Consent Form (ICF) in accordance with Ordinance No. 466/2012.

The study included all leprosy patients diagnosed between 2017 and 2019 that agreed to sign ICF, N=27 of both sexes and different ages, in one medium (50 to 100 thousand inhabitants) and one large (100,001 to 900,000 inhabitants) Brazilian municipality under treatment or undergoing chemotherapy. A control group of 27 people, chosen from the population without a diagnosis of leprosy, was evaluated by pairing age and sex, thus totaling 54 people. Data collection, was done as summarised in Data Collection Instrument. It went from December 2017 to November 2019, until three evaluations were completed, with an average interval of 3 months between evaluations.

Exclusion criterion for both groups were those with compressive syndromes of the CNS and PNS, spinal disorders, other diseases of the CNS such as stroke or degenerative syndromes, diabetics and alcoholics with altered sensitivity and those who refused to sign the ICF.

Initially, a patient profile data sheet extracted from their medical records was used, with the name, address, age, sex, date of the beginning of treatment, date of discharge, clinical classification of leprosy and type of treatment. In the control group, name, address, age, sex and existing morbidities were used. Evaluation instruments were applied:

- **Simplified Neurological Assessment (SNA)** is a protocol recommended by the Brazilian Ministry of Health, and it contemplates dermatoneurological exploration, the evaluation of eyes, hands and feet sensitivity, and the evaluation of the motor function (Brazilian Ministry of Health 2017). In this clinical examination, the integrity of the skin and its nutrition are assessed. Testing quick perception of a light touch and/or deep pressure (Brazilian Ministry of Health 2017). It is recommended to use the Semmes-Weinstein monofilament set (6 monofilaments: 0.05g, 0.2g, 2g, 4g, 10g and 300g) in the sensitivity assessment points in hands and feet (Brazilian Ministry of Health 2017). To assess motor strength, it is recommended to perform manual testing of muscle strength in the muscle-tendon unit, grading from 0 to 5 following the Kendall scale in each muscle group from a specific nerve-myotome (Brazilian Ministry of Health 2017).
- **WHO Degree of Physical Disability (DPD**) indicates the loss of protective sensitivity, muscle strength and/or visible deformities in the face, ULs and LLs, varies between Degree 0 (no leprosy-related physical disability), I (decreased strength and/or loss of sensation) or II (presence of visible disabilities and deformities) according to the severity of sensory and/or motor and/or morphological changes caused by neural lesions of leprosy (Brazilian Ministry of Health 2017).
- **Neurodynamic tests**: straight leg raises (SLR), Slump Test and upper limb tension tests (ULTT) 1, 2b and 3 (Butler & Jones 2003).
    - **I. SLR test** is performed with the patient in the supine position, with the trunk and hips in neutral positions. The examiner places one hand under the Achilles tendon and the other above the knee. The hip is flexed with the knee held in extension until it reveals a predetermined symptomatic response or until it reaches its hip range of motion (ROM)

Medical School Of São José Do Rio Preto

Data Collection Instrument

	PATIENT'S (PERSON) PROFILE DATA
1	Record Number _____ 1( )SJRP 2( )Votuporanga
2	Name _____
3	BirthDate ___ /____/____ Age:_____ Years
4	Sexo: 1( ) male 2( ) female
	OFFICIAL ADDRESS
5	Street_____ nº____ CEP:_____ Phone:_____ _____
6	Ocupation:_____
	EXCLUSION CRITERIA
7	Diabetic? 1( ) Yes 2 ( )No
8	Compressive syndromes of the cent ral and periferal nervous system? 1 ( ) Yes 2 ( ) No. Which? _____
9	**Alcoholic** 1 ( ) Yes 2 ( ) No
	LEPROSY DATA
10	**Clinical Classification:** 1 ( ) LII 2 ( ) LTT 3 ( ) LDT 4 ( ) LDD 5 ( ) LDV 6 ( ) LVV 7 ( ) Pure Neural
11	**MDT (Multidrugtherapy):** 1 ( ) PB 2( ) MB
12	**Dates:** Start of treatment: ___/___/___ dischargue date of PCT: ___/___/__
13	**Pacient's Situation:** 1 ( ) Dsicharge 2 ( ) in treatment

14	**Reacionalstate:** 1 ( ) yes 2( ) no. If yes, which: _____ 1 ( ) ENL 2 ( ) RR 3 ( ) ENL + RR 4 ( ) Neuritis 6 ( ) *Lucius Phenomenon* 7 ( ) Vasculitis 8 ( ) Orbaneja
15	Observe the following scale and report the degree of pain at this point: 0 ( ) 1 ( ) 2 ( ) 3 ( ) 4 ( ) 5 ( ) 6 ( ) 7 ( ) 8 ( ) 9 ( ) 10 ( ).

1st Assess	2nd Assess	3rd Assess

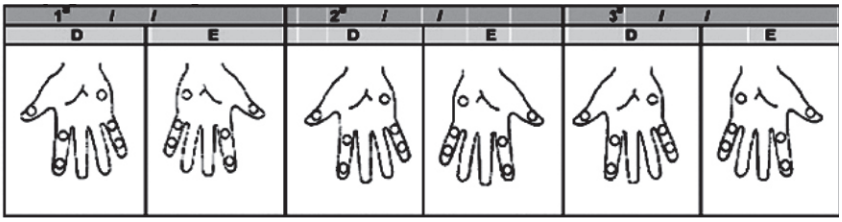
16	**Palpation of Nerves Upper Limbs** – 1: normal; 2: thickening; 3: pain; 4: pain + thickening	1st Assess		2nd Assess		3rd Assess	
		R	L	R	L	R	L
	Ulnar						
	Median						
	Radial						
17	**Strength Assessment – Upper Limbs** – 0: Grade Zero; 1: Grade I; 2: Grade II; 3: Grade III; 4: Grade IV; 5: Grade V	1st Assess		2nd Assess		3rd Assess	
		R	L	R	L	R	L
	5th Finger Abduction						
	Thumb abduction						
	Wrist extension						
18	**Inspection UL:** 1 claw; 2 reabsortion of extremities; 3 contracture; 4 ulcers; 5 Normal	1st Assess		2nd Assess		3rd Assess	
		R	L	R	L	R	L
19							
	Palpation of Nerves Lower Limbs – 1: normal; 2: thickening; 3: pain; 4: pain + thickening	1st Assess		2nd Assess		3rd Assess	
		R	L	R	L	R	L
	Fibular						
	Posterior Tibial						

20	**Strength Assessment–Lower Limbs** – 0: Grade Zero; 1: Grade I; 2: Grade II; 3: Grade III; 4: Grade IV; 5: Grade V	1st Assess		2nd Assess		3rd Assess	
		R	L	R	L	R	L
	Hallux Extension						
	Dorsiflexion						

21	**Inspection LL :** 1 claws; 2 reabsortion of extremities; 3 contracture; 4 ulcers; 5 Normal	1st Assess		2nd Assess		3rd Assess	
		R	L	R	L	R	L

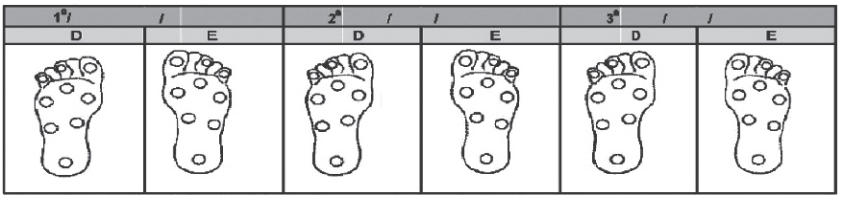
Sensitivity assessment of Upper Limbs: (1) Normal sensitivity (2) Loss of sensitivity

22



23 **SensitivityAssessment of Lower Limbs**

23 **SensitivityAssessment of Lower Limbs**



24 **DPD – Degree of Physical Disability**

1 ( ) Degree zero – without disability
2 ( ) Degree 1- Loss of sensation and/or loss of strength of hands and feet
3 ( ) Degree 2- Visible deformity (hands and feet drop, claw hands, plantar ulcers, reabsorption of the extremities)

	1st Assess		2nd Assess		3rd Assess	
	R	L	R	L	R	L
Hand						
Foot						

	Passive Neck Flexion (PNF)									
	Goniometry ( ) 65º		1st Assess		2nd Assess			3rd Assess		
25	1 ( ) Positive 2 ( ) Negative									
	Interviewer's observation									
	Straight Leg Raise (SLR)		1st Assess		2nd Assess			3rd Assess		
			R	L	R	L		R	L	
	Expected Goniometry 50-120º									
26	Pain: VAS									
	1 Positive 2 Negative									
	Interviewer's observation									
	Test	**Variable**	1st Assess		2nd Assess		3rd Assess		Expected Goniometry	
			R	L	R	L	R	L		
27	ULTT1 MEDIAN	Elbow							145º flexion	
		Wrist							70º extension	
	Pain (VAS)	Elbow								
		Wrist								
	Positive 1 Negative 2									
	Interviewer's observation									
28	ULTT2b RADIAL	Elbow							145º flexion	
		Wrist							90º flexion	
	Pain (VAS)	Elbow								
		Wrist								
	Positivo 1 Negativo 2									
Interviewer's observation										
29	ULTT3 ULNAR	Elbow							145º flexion	
		Wrist							70º extension	
	Pain (VAS)	Elbow								
		Wrist								
	Positive 1 Negative 2									
	Interviewer's observation									
30	PKB	Knee + Hip Ext							10º H E + 140 º Knee Flexion	
		Knee							140º Knee Flexion	
	Pain (VAS)	Knee + Hip Ext								
		Knee								
	Positive 1 Negative 2									

	Interviewer's observation								
31	ULTT3 + ABD H + RI ULNAR	Elbow							145º flexion
		Wrist							70º extension
	Pain (VAS)	Elbow							
		Wrist							
	Positive 1 Negative 2								
Interviewer's observation									

	Slump test	1st assess		2nd assess		3rd assess	
		R	L	R	L	R	L
	Knee Extension Goniometry 0º						
32	Pain: VAS						
	1 Positive 2 Negative						
	Interviewer's observation						

limit. SLR normal ROM varies from 50° to 120° (Butler & Jones 2003). Test is considered positive in individuals with leprosy, if discomfort/ pain, pins, needles, sensation changes, pulling, tension, numbness or tingling that radiates inferiorly through the posterior / lateral sides of the leg, often associated with paresthesia is reported or expressed in the limb, reproduction of symptoms usually in the course of innervation, or when the physical therapist encounters resistance to movement. Neural tension can be caused by compression or incarceration of the peripheral nerve (Herrington et al 2008).

II. **Slump Test** is performed with the patient seated, with the thighs fully supported, the knees together and the hands together on the back. The patient is asked to flex the thoracic and lumbar spine soon after, and also perform cervical flexion. The physiotherapist puts pressure on the cervical region in order to accentuate flexion. Patient performs an active knee extension associated with dorsal flexion of the ankle. Cervical flexion is slowly released, and the painful response must be carefully evaluated. The symptoms must be noted at each stage and must also be performed for the other member. ROM and painful responses should be assessed (Butler & Jones 2003).

III. **ULTT1 test** assesses the median nerve with the patient in the supine position. The examiner exerts force to depress the scapular waist, which has an external rotation and 110° abduction of the

glenohumeral articulation, elbow extension, radioulnar supination and, wrist and fingers extension; the inclination of the cervical to the opposite side was suppressed in our assessment to isolate core involvements. Tests are considered positive if present: complaint at deep elongation or pain in the cubital fossa that extends down the anterior and radial part of the forearm and to the radial side of the hand; tingling sensation in the first four fingers; stretching in the anterior shoulder area (Butler & Jones 2003).

IV. **ULTT 2b test** assesses the radial nerve with the patient in the supine position. The examiner holds the elbow and wrist of the patient. Using the thigh, the examiner depresses the scapular waist and internally rotates the shoulder, extends the elbow, and flexes the wrist, fingers and thumb (Butler & Jones 2003).

V. **ULTT 3 test** assesses ulnarnerve with the patient in the supine position, keeping the wrist of the patient extended and the forearm supine, and performing an elbow flexion. After performing a shoulder depression associated with an external rotation (Scheibe et al 2012). The test is considered positive when the patient reports any discomfort/pain or when the physical therapist encounters resistance to movement. Pain is intermittent, deep and burning in quality. Also, a cold, tingling feeling extended distally from the medial elbow to the little finger (Shacklock 1996).

The leprosy group underwent 3 evaluations quarterly, and the control group was evaluated in a single moment. None of the subjects were in a reaction episode at the time of the evaluation. The application of the data collection instrument took 50 minutes and was performed by a single examiner. In this study, we intend to prioritize excellence in the methodological criteria of each of the evaluations, and for this reason, all cases were evaluated by a single evaluator.

Data Analysis

SNA was assigned with a value “without changes” or with the value “with changes” for the ULs and LLs. We considered that the change in sensitivity in hands decreased when the individual didn't feel the 0,02g green monofilament. The decrease in plantar sensitivity was considered when didn't feel the 0,5g blue monofilament. The muscle strength domain was also considered to perform SNA grouping and was coded as “altered” when muscle strength was less than 5, identifying a muscular paresis and, therefore a neurological alteration (Brazilian Ministry of Health 2017). The palpation was marked as altered when there was pain, thickening, or both.

- We synthesize the results of the NDA in positive and negative tests, considering the set of tests for the ULs and LLs one apart from the other.
- DPD was classified as “*without disability*” when it was Degree 0, and was grouped as “*disabled*” when its results were Degrees 1 or 2.

After tabulation of the data collected in this work, 2 analytical and statistical functions were performed: descriptive and inferential. In a descriptive way, the profile of the studied sample was drawn, considering the analyzed variables and their consequences, and the data was replicated in an absolute and relative way.

In the inferential scope, the analysis of independence and prediction between variables was drawn as a statistical objective. In addition, the Mann-Whitney U test and Multivariate Linear

Regression were used with the results of independence between the proposed variables, taking into account the P-values (significance $P \leq 0.05$). All analyses were obtained using the SPSS Statistics Software (Version 23), Excel (version 2016) and EPI INFO 7.1 statistical software. Statistical analysis and synthesis of the results were performed on a Venn-Euler diagram.

Results

In this study, all 27 individuals diagnosed with leprosy who were notified in the years 2017 to 2019 participated, in addition to 27 volunteers matched for age and sex in the control group, totaling 54 people. Among the study group, 17 (63%) were male. The ages varied between 23 and 88 years in the control group and between 23 and 87 years in the study group, with a mean age of 53.1 (SD 17.6). The age median in the control group was 57, while in the study group it was 55.

The age distribution was identical in control and study groups due to the pairing (n=54) (p-value 0.945). There was no difference in sex (p-value

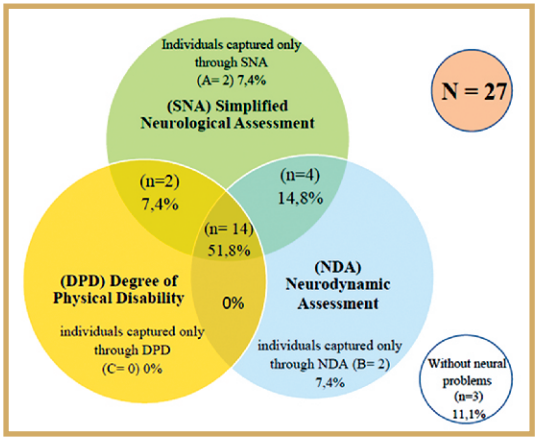


Fig 1 : Intersection of three assessments used to check upper limbs (ULs) neurological injuries of individuals with leprosy using the Venn-Euler Diagram

SNA: Simplified Neurological Assessment; DPD: Degree of Physical Disability; NDA: Neurodynamic Assessment. SNA identified neural injury in 22 individuals, NDA in 20 individuals and DPD in 16. The intersection zones correspond to individuals captured by 2 or 3 assessment instruments. The numbers outside the intersections mean the individuals who are captured only by that specific assessment. A = individuals captured only by SNA, B = individuals captured only by NDA, C = individuals captured only by DPD.

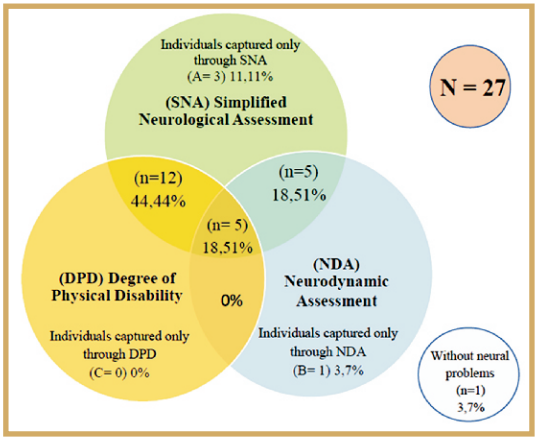


Fig. 2 : Intersection of the results obtained from the three assessments used to verify neurological injuries in the lower limbs (LLs) of individuals with leprosy

SNA: Simplified Neurological Assessment; DPD: Degree of Physical Disability; NDA: Neurodynamic Assessment. SNA identified neural injury in 25 individuals, NDA in 11 individuals and DPD in 17. The intersection zones correspond to individuals captured by 2 or 3 assessment instruments. The numbers outside the intersections mean the individuals who are captured only by that specific assessment. A= individuals captured only through SNA, B = individuals captured only through NDA, C = individuals captured only through DPD.

1.00). In the study group there were 19 (70.4%), active workers; in the control group, it was 22 (81.5%) (p-value 0.344).

Regarding leprosy, 20 (74.1%) of the participants in the study group had the dimorphous and Virchow's leprosy clinical forms, with multi-bacillary multidrug therapy (74.1%). Seven (25.9%) patients had a reaction phenomenon to leprosy during the treatment but not at the time of the evaluations. 25 (92.6%) still remained under drug treatment, 11 (40.7%) were evaluated in less than 30 days after diagnosis, 4 (14.8%) were evaluated in less than 60 days after diagnosis, 1 (3.7%) were evaluated in less than 90 days after diagnosis, 3 (11.1%) before 180 days after diagnosis, 3 (11,1%) before 270 days after diagnosis and 3(11.1%) before completing 365 days between diagnosis and first evaluation. 2 (7.4%) patients were evaluated after the discharge.

The participants in the study group showed neurological changes, at least in one site of the ULs, assessed by the three types of exams. In Fig. 1 there is a sintesis of the 3 diagnostic tools performed isolated and in combination. The test that most captured data was the SNA with 22 (81.5%) participants, followed by the NDA, where 20 (74.1%) were altered, and the DPD showed deficiency in the hands of 16 (59.2%) individuals.

As assessing the LLs, it appears that in the study group the participants showed neurological changes in the three assessments studied. In Fig. 2 there is a sintesis of the 3 diagnostic tools performed isolated and in combination. Neurological changes were more perceived by SNA, attested in 25 (92.6%) participants. The DPD showed a disability in 17 (62.9%) individuals. In the NDA, 11 (40.7%) showed alterations. In the control group, no neurological changes were identified by the 3 instruments, confirming the reliability of the sample (Table 1).

DPD of hand and foot compared to the SNAand NDA of ULs and LLs

DPD of the hands shows agreement in 21 (77.8%) of the cases that were assessed by SNA (P-value =

Table 1 : Distribution of the results of the Simplified Neurological Assessment, degree of hand and foot disabilities, neurodynamic test of the upper and lower limbs in the studygroup (N=27)

TESTS	RESULTS	LIMBS							
		Study Group				Control Group			
		Upper		Lower		Upper		Lower	
		N	%	N	%	N	%	N	%
Simplified Neurological Assessment	No alteration	5	18.52	2	7.41	27	100	27	100
	Alteration	22	81.48	25	92.59	0	0	0	0
Degree of Physical Disability	No disability (Degree zero)	11	40.74	10	37.04	27	100	27	100
	Disability (Degree I and II)	16	59.26	17	62.96	0	0	0	0
Neurodynamic Assessment	Negative	7	25.93	16	59.26	27	100	27	100
	Positive	20	74.07	11	40.74	0	0	0	0

0.010). SNA made the diagnosis of neural injury in 6 (22.3%) cases that, according to the DPD, did not have a physical disability (DPD zero).

Regarding the association of DPD of hand with the NDA in 14 (51.8%) of the patients evaluated, there were agreed with positive results; in 5 (18.5%) there were agreed negative results. The results differed in eight participants, with the NDA more frequently capturing neural changes 6 (22.2%) than the DPD 2 (7.4%) (p-value = 0.143).

The comparison between the DPD of the feet and the SNA of the LLs was acceptable in 17 (62.9%) of the cases but diverged in 8 (29.6%) cases, exposing a greater sensitivity of the SNA in showing the neural damage (p-value=0.060).

Verifying the DPD of the feet and the NDA of the LLs showed an agreement of positive results in 5 (18.5%) of the patients evaluated and in 4 (14.8%) of the negative results. In eighteen participants, the results differed; the DPD of the feet more frequently captured neural changes 12 (44.4%) than the NDA 6 (22.2%) (p-value=0.125) (Table 2).

SNA compared to NDA in the ULs and LLs

By checking the SNA and the NDA in the ULs, we found agreement on the positive results in 18 (66.7%) of the cases with neurological changes and in 3 (11.1%) of the cases without changes with negative tests. There was disagreement in six individuals. The SNA was more effective in verifying the neurological changes of the ULs in 4 (14.8%) cases, while the NDA identified it in 2 (7.4%) cases.

The association between SNA and the NDA of LLs showed agreement on positive results in 10 (37%)

Table 2 : Degree of hand and foot disabilities compared to Simplified Neurological Assessment and Neurodynamic Assessment in upper limbs and lower limbs when applied to the studygroup (N=27)

Uls	**Simplified Neurological Assessment**	**DEGREE OF HANDS DISABILITIES**				**P-value**
		No Disability		**Disability**		
		N	**%**	**N**	**%**	
	No alteration	5	18.51	0	0.00	0.010
	Alteration	6	22.33	16	59.25	
	Neurodynamic Assessment	**No Disability**		**Disability**		
		N	**%**	**N**	**%**	
	Negative	5	18.51	2	7.41	0.143
	Positive	6	22.22	14	51.85	
LLs	**Simplified Neurological Assessment**	**DEGREE OF FEET DISABILITY**				
		No Disability		**Disability**		
		N	**%**	**N**	**%**	
	No alteration	2	7.41	0	0.00	0.060
	Alteration	8	29.62	17	62.96	
	Neurodynamic Assessment	**No Disability**		**Disability**		
		N	**%**	**n**	**%**	
	Negative	4	14.81	12	44.44	0.125
	Positive	6	22.22	5	18.51	

Table 3 : Simplified Neurological Assessment compared to Neurodynamic Assessment, in the upper and lower limbs, when applied to the studygroup

		SIMPLIFIED NEUROLOGICAL ASSESSMENT				p-value
	NEURODYNAMIC ASSESSMENT	No Alteration		Alteration		
		N	%	n	%	
Upper limbs	Negative	3	11.11	4	14.81	0.059
	Positive	2	7.41	18	66.67	
		No Alteration		**Alteration**		
Upper limbs	Negative	1	3.70	15	55.56	0.786
	Positive	1	3.70	10	37.04	

of the patients evaluated and in 1 (3.7%) of the negative results. In sixteen participants, the results differed; the SNA ofLLs more frequently captured neural changes 15 (55.5%) than the NDA of the LLs 1 (3.7%)(p-value=0.786) (Table 3).

Discussion

With this study, we hoped to identify an evaluation protocol that used only human resources for its execution, facilitating the identification of neural lesions in leprosy combined with the daily practice of physical therapists that are not involved in the management of leprosy but routinely use NDA. In this way, more suspicions and diagnoses of the disease could be made and would help in cases that present themselves as purely neural. Concerning leprosy, it is important that not only the physician suspects the disease, but any health professional.

There was no statistical difference in relation to sex, age and occupation in the two groups studied since the pairing was performed to avoid the effect of age and sex, two recognized confounding factors for the results (Caminha et al 2015, PAHO 2005), so a comparison was made between groups, showing similarity and equal care between them (Guyatt et al 1993, PEDro 2020).

Regarding neurological tests, the one that most captured neural alterations was the SNA in both ULs and LLs, highlighting the importance of the process of identifying the DPD through SNA, at the beginning of treatment and after discharge (Finez & Salotti 2011). Studies show worsening physical disabilities during treatment, mainly in the multibacillary form, with the LLs being the segments that show the most significant DPD evolution, justifying the imperative need for more careful monitoring of these cases through routine assessments and interventions (Vieira et al 2016).

In the univariate and multivariate analysis, there is an agreement between the result found in the DPD with the SNA in the ULs. Since disability is only considered when sensitivity is decreased beyond purple monofilament and/or muscle strength is less than 5, DPD does not detect the subtle changes that suggest neural distress, and we emphasize that the SNA made the diagnosis of neural injury in 6 (22.3%) of the cases while, according to the DPD, those cases did not yet present disabilities, showing the importance of using and applying SNA. The DPD was an innovative measure to gradually quantify physical disability in an index and was not designed to be sensitive to early changes (Santos & Ignotti 2019).

The DPD is recommended at the beginning of treatment and discharge (Finez & Salotti 2011)

but when the patient shows a slight improvement, there is no variation in the DPD, and the services are unable to assess whether the actions developed are being effective (Nardi et al 2011).

As an indicator, there is a fragile and subjective comparison of the DPD with the limitation of activities, and the social participation of the patients is not included in its results. An adaptation of the indicator is necessary to develop a more current classification based on a more comprehensive concept of disability, as is done by the International Classification of Functioning (ICF) (De Souza et al 2016).

Nerve damage is associated with physical disabilities. Thus, regular monitoring of nerve function through SNA, combined with the adequate clinical management of neuritis, neuropathies and leprosy reactions, are effective strategies to prevent it (Silva et al 2019).

Considering leprosy and NDA, a study of ULs found a positive NDA, mainly affecting those with a DPD 2. Of these, they presented a decrease in the ROM of elbow flexion in the ulnar neural tension test (ULTT3) on both sides when compared to the control group (Sheibe et al 2012).

Leprosy patients test positive when submitted to NDA of LLs (Véras et al 2012). But, even when the tests do not reproduce the symptoms in the affected nerves, characterizing negative tests, studies suggest that neuropathy cannot be ruled out yet; this can mean a more severe lesion with demyelination of the fibres (Thoomes et al 2018) (as occurred in DPD 2 patients that tested negative in the LLs in our analysis), producing a possible false-negative result, thus explaining the low sensitivity of the in LLs (Ferreira & Patino 2017).

Both in the univariate and multivariate analysis of ULs and LLs, when comparing the SNA with the NDA, we note that the SNA identifies the neural lesion earlier than the NDA.

According to the evidence available in 2019, it is suggested that neurodynamic tests should not be used in isolation as a single test to diagnose neural distress of the median nerve. They should be interpreted in the context of a loss of function tests of small fibers in a domain (Koulidis et al 2019). Combining anamnesis and clinical history is an important tool to make a differential diagnosis, where the combination of negative neurodynamic test results could be used to rule out a disorder in the peripheral nerves (Thoomes et al 2018).

Neurodynamic tests can reveal disorders originating from compression of the CNS or PNS. The evaluator must have the clinical experience to understand when the positive result comes from central or peripheral compression. A person with leprosy may have an undiagnosed spinal pathology (Butler 1989, Butler & Jones 2003).

In this sense, the scientific community highlights the need for more possibilities for neural injury investigations in leprosy to diagnose and monitor the neurological changes caused by it. A study in Nigeria points out that 50% of patients who complete treatment already had neurological changes before diagnosis, but 90%, when receiving assistance and monitoring of injuries, end treatment with less disability (Onyeonoro et al 2016). Neural damage needs to be identified early, and current leprosy control efforts must be intensified to ensure an immediate treatment to reduce the burden of the disease, including deficiencies in individuals and the community (Nardi et al 2011, Raposo et al 2011).

In our study, neurodynamic tests were positive in 2 (7.4%) individuals while there were still no changes in SNA and later, these changes appeared, which makes us think of the association of assessments as a way to complement the diagnosis and monitoring of neural changes.

Therefore, a need to create an assessment (validated or not) is necessary so that we can, reveal the neural lesion more precociously, given that 95% of patients have neurological changes, with musculoskeletal symptoms, which interfere in their functional capacities, causing difficulties in performing their activities of daily living and work when compared to those who have no symptoms. However, the presence of disability did not prevent or limit them from performing these activities. Even with the pain, paresthesia decreased strength and other injuries, they still perform their activities (Do Prado et al 2011).

Despite covering a health macro-region, the sample of 27 subjects was a limitation in the study, preventing us from using a blind, controlled and randomized study, which would provide greater methodological robustness. We suggest that future studies in this area assess this possibility and may also include a third control group with patients with other neurological disorders not caused by leprosy.

Conclusions

We conclude that the 3 assessment instruments can and should be used in combination to expand the monitoring of neural lesions in leprosy, as there are changes that are not perceptible with one instrument but can be confirmed by another. Opti for SNA, if you choose only one, instrument, because it is the one that identifies more subtle changes and captured more neural alterations that suggest neural distress.

Both NDA and DPD do not identify subtle changes that suggest neural distress, while SNA identifies. Therefore, that is, reporting that nerves are healthy, when in fact, their are some neurological changes already, implying that some individuals may not receive the proper treatment as early as possible.

NDA did-not establish a statistical relationship of dependency with DPD instruments, nor with SNA; in its application to investigate neural injury in people who have leprosy, it did not prove to be such a sensitive tool in isolation, but when associated with clinical anamnesis and evaluations already used, DPD and SNA, it facilitates diagnosis, impacting the suspicion of new cases of the disease.

The association of leprosy and neurodynamics issues alerts professionals who are not involved with leprosy to suspect leprosy neuropathy when they find a positive neurodynamic test in their clinical practice.

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