Functional evaluation of the hand after ulnar claw correction in patients with leprosy

BERNARDO COUTO NETO*, ANA PAULA FONTANA**, DIOGO CORREIA SILVA***, ELIFAZ DE FREITAS****, ANTÔNIO JOSÉ LEDO ALVES DA CUNHA*****; VAGNER WILIAN BATISTA E SÁ****** & MARIA KATIA GOMES***

*Universidade Federal Fluminense, Rua Marques de Paraná, 303 Niterói, 24230-030, Rio de Janeiro, RJ, Brazil, and Hospital Universitário Pedro Ernesto da Universidade do Estado do Rio de Janeiro, Boulevard 28 de Setembro, 77 - Vila Isabel, Rio de Janeiro RJ, 20551-030

**Faculdade de Medicina, Universidade Federal do Rio de Janeiro, Avenida Carlos Chagas Filho 373, CCS, Block K, Sala K2-49, Cidade Universitária, 21941-902 Ilha do Fundão, RJ, Brazil

***Hospital Universitário Clementino Fraga Filho e Departamento de Medicina de Família e Comunidade/Faculdade de Medicina da Universidade Federal do Rio de Janeiro, Rio de Janeiro, RJ, Brazil

****Departamento de Cirurgia Ortopédica, Hospital Santa Marcelina, BR-364, KM 17, 313-Zona Rural, Porto Velho – RO, Brazil

*****Faculdade de Medicina da Universidade Federal do Rio de Janeiro, Departamento de Pediatria, Rua Bruno Lobo, No. 50, Cidade Universitária, Rio de Janeiro, Brazil

******Universidade Estácio de Sá, Av. Dom Helder Câmara, 5474, Cachambi, Rio de Janeiro, RJ, Brazil

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Summary

Purpose: To evaluate hand function in leprosy patients after reconstructive surgery for claw hand.

Methods: Patients who had completed multidrug therapy (MDT) and who had undergone tendon transfer surgery for ulnar claw correction at either of two reference centres for leprosy in Brazil between 2010 and 2014, were included. Clinical
evaluations, Screening of Activity Limitation and Safety Awareness (SALSA) Scale, Disabilities of the Arm, Shoulder, and Hand Score (DASH) Questionnaire and the Jebsen Taylor Test (JTT) were used to measure arm/hand function recovery after surgery. Data were analyzed with the one sample t-test \((p < 0.05)\).

**Results:** Twenty-three patients participated in the study, with 13 males \((57\%)\), a mean age of 49.5 years and an average of 6.3 years post-surgery. On the SALSA Scale total score, 59\% of the individuals had mild or no limitation of activity. On the specific score for the hand domain, 91\% had mild or no limitation. The mean score of the DASH Questionnaire was 24.45. On the JTT, when comparing individuals who had surgery on the right hand with normative values for the dominant hand, matched for mean age and gender, there was a significant difference for all six tasks. When comparing individuals who had surgery on the left hand with normative values for the non-dominant hand, there was greater proximity between the means, although still significantly different.

**Conclusions:** The SALSA, DASH and JTT were easily applicable and useful to measure the functional limitation of the leprosy hand. The data demonstrated that the patients had a good impression of their hand’s improved functionality after surgery. Patients exhibited mild to no disability. These results reinforce the importance of early diagnosis of neuritis and immediate therapeutic interventions to prevent physical disability.

**Level of evidence:** Therapeutic study - Level III

**Keywords:** claw hand, functional evaluation, nerve decompression, leprosy

### Introduction

Leprosy is considered a public health problem in Central Africa, Southeast Asia and Latin America, and had a recorded incidence of 219,075 cases in 2012. Worldwide, approximately 15 million people have been treated with Multi-drug Therapy (MDT).¹

Early detection and adequate treatment decreases the risk of disability in leprosy patients. However, 11\% to 51\% of people do not fully recover normal nerve function and 6\% to 27\% develop secondary disabilities, which generally causes restriction of daily activities.²

In 2014, 31,000 cases were reported in Brazil, with a detection rate of 15.31 cases per 100,000 inhabitants and a prevalence rate of 1.56 cases per 10,000 inhabitants, putting the country second in the global ranking, behind India.³ Although the detection rate is decreasing, the proportion of new cases with WHO Grade 2 disability (G2D) is increasing.⁴ In 2016, there was a detection rate of cases with G2D of one case per 100,000 inhabitants.⁴,⁵

Leprosy is not just a contagious skin disease; it can compromise peripheral nerves, generating sensory and motor abnormalities in the limbs that cause disabilities, and feared and stigmatizing deformities. The ‘claw hand’, a complication of impairment of the ulnar nerve in leprosy, immediately shows the individual to be ‘affected by leprosy’, especially in countries where the disease is endemic.²,⁶–¹⁰ (Figure 1).

Preventive surgical decompression of peripheral nerves and reparative tendon transfer surgery in leprosy are procedures that must be considered to ensure comprehensive care. In leprosy, surgery aims to make corrections to deformities and disabilities. Studies recording the limitations of manual activities before and after restorative surgery of ulnar claw are scarce, making it difficult to plan actions to prevent limitations when performing daily living
activities. The surgical techniques suggested by the Brazil Leprosy Manual used for correcting claw hand are the Stiles-Bunnell-Brand technique and the Zancolli Technique (Lace Technique). The first is a technique considered as physiologic because the transferred tendons follow the same path as the non-functioning lumbricals. The approach and suturing of the tendon, transferred into the extensor apparatus, provides a better condition for the extension of middle and distal phalanges. The Zancolli technique, on the other hand, is recommended for patients with joint hypermobility.

In this study we evaluated the function of the hand in patients with leprosy who underwent tendon transfer surgery to repair an ulnar claw using the tools: SALSA Scale, the DASH questionnaire and the Jebsen & Taylor’s test.

**Materials and Methods**

**SAMPLE**

All participants provided written, informed consent, consistent with the Declaration of Helsinki. This study was approved by the Human Research Ethics Committee (CEP-HUCFF/UFRJ from the Universidade Federal do Rio de Janeiro, reference 143/09); a cross-sectional study design was chosen to assess patients who underwent surgery for ulnar claw correction at two reference centres for leprosy in Brazil, Santa Marcelina Hospital, Porto Velho/RO and HUCFF/UFRJ in Rio de Janeiro, during the period 2010–2014.

**Inclusion criteria:**

- Patients who completed MDT, who underwent tendon transfer surgery for ulnar claw correction (G2D), were enrolled in the study.

**Exclusion criteria:**

- Patients who underwent tendon transfer with the diagnosis of another disease causing peripheral neuropathy.
EVALUATION INSTRUMENTS

Neural Evaluation

For sensory-motor assessment, the evaluation form from the Brazilian Ministry of Health, known as simplified neural evaluation, was used; it is divided into inspection, palpation, sensitivity testing and muscle strength evaluation, with eyes, hands and feet being evaluated.\(^\text{15}\)

Jebsen Taylor’s Test

This test includes a series of seven everyday tasks: writing, turning cards, picking up small objects and putting them in a container, simulating feeding, stacking coins, picking up big and light objects and picking up big and heavy objects. The test is recorded and, then, the time of task execution in seconds is extracted. Through seven functional tasks, JTT evaluates the grip, grasp and object manipulation functions of the hand.\(^\text{16}\)

Screening of Activity Limitation and Safety Awareness (SALSA scale)

Besides being validated in Brazil, it has been applied in different sociocultural scenarios to assess the functional limitations of people who have peripheral neuropathies, especially diabetes and leprosy.\(^\text{17,18}\) Two analyses were performed, one with the total score of the 20 items of SALSA and another with only the items related to activities depending on manual function. As for the analysis of scores related to the three domains related to the hand (self-care, dexterity and handwork), the results of 15 items were evaluated. After obtaining the final score, a proportional percentage was made and the result for the ‘SALSA manual’ was recorded.\(^\text{17}\)

The Disabilities of the Arm, Shoulder and Hand Score (DASH questionnaire)

The DASH questionnaire assesses function and symptoms in upper limbs from the patient’s perspective. It has been shown to be valid and reliable and has been used in studies of clinical outcomes as a measurement of function, in addition to measuring the impact of health conditions that affect upper limb functionality. It has 30 questions and the score ranges from 0 (maximum functionality) to 100 (maximum incapacity). Optional modules (Work Module and sport/music Module) were not used in this study.\(^\text{19}\)

DATA ANALYSIS

The JTT was individually recorded in video for all subjects for further editing. As it has low internal consistency,\(^\text{20}\) the first task (writing) was excluded from the analysis.

Temporal data obtained were analysed according to the mean and standard deviation of recorded task times by patients and compared with the average of times of the normal male population (20–59 years, \(n = 120\)) - Reference Data: Original Article J&T\(^\text{16}\) (1969) - using one-sample t-tests \((p < 0.05)\). Three experienced independent researchers performed the evaluation of each patient.
Table 1. Sample characterisation

<table>
<thead>
<tr>
<th></th>
<th>Gender</th>
<th>Hand dominance</th>
<th>Operated member</th>
<th>Time of surgery/years</th>
<th>Operational classification</th>
<th>PCT discharge</th>
<th>G.I of the hand before surgery</th>
<th>Neurolysis in the same member?</th>
<th>Neurolysis for how long?</th>
</tr>
</thead>
<tbody>
<tr>
<td>P1</td>
<td>F</td>
<td>Right</td>
<td>L</td>
<td>6y 4m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>4y</td>
</tr>
<tr>
<td>P2</td>
<td>M</td>
<td>Right</td>
<td>R</td>
<td>4y 3m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>9y 3m</td>
</tr>
<tr>
<td>P3</td>
<td>M</td>
<td>Right</td>
<td>L</td>
<td>4y 5m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>3y 3m</td>
</tr>
<tr>
<td>P4</td>
<td>M</td>
<td>Right</td>
<td>L</td>
<td>6y 9m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>8y 8m</td>
</tr>
<tr>
<td>P5</td>
<td>M</td>
<td>Right</td>
<td>R</td>
<td>2y</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>10y 3m</td>
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<td>R</td>
<td>4y 10m</td>
<td>MB</td>
<td>&gt;12m</td>
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<td>6y</td>
</tr>
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<td>L</td>
<td>4y 10m</td>
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<td>R</td>
<td>2y 6m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>5y</td>
</tr>
<tr>
<td>P9</td>
<td>F</td>
<td>Right</td>
<td>L</td>
<td>3y 2m</td>
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<td>II</td>
<td>NO</td>
<td>NR</td>
</tr>
<tr>
<td>P10</td>
<td>M</td>
<td>Right</td>
<td>L</td>
<td>4y 10m</td>
<td>PB</td>
<td>11th</td>
<td>II</td>
<td>YES</td>
<td>13y 2m</td>
</tr>
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<td>Right</td>
<td>L</td>
<td>3y</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
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<td>NR</td>
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<td>R</td>
<td>9y 10m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>8y 2m</td>
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<tr>
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<td>Right</td>
<td>R</td>
<td>3y 7m</td>
<td>MB</td>
<td>6th</td>
<td>II</td>
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<td>3y 7m</td>
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<td>R</td>
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<td>MB</td>
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<td>II</td>
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<td>6y 2m</td>
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<td>L</td>
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<td>MB</td>
<td>26</td>
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<td>YES</td>
<td>16</td>
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<td>MB</td>
<td>&gt;12m</td>
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<td>R</td>
<td>2y 1m</td>
<td>MB</td>
<td>&gt;12m</td>
<td>II</td>
<td>YES</td>
<td>5y 2m</td>
</tr>
<tr>
<td>P18</td>
<td>F</td>
<td>Right</td>
<td>R</td>
<td>23y 6m</td>
<td>PB</td>
<td>&gt;12m</td>
<td>II</td>
<td>NO</td>
<td>NR</td>
</tr>
<tr>
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<td>M</td>
<td>Right</td>
<td>R</td>
<td>4y</td>
<td>MB</td>
<td>7th</td>
<td>II</td>
<td>NO</td>
<td>NR</td>
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<tr>
<td>P20</td>
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<td>Right</td>
<td>R</td>
<td>4y</td>
<td>MB</td>
<td>7th</td>
<td>II</td>
<td>NO</td>
<td>NR</td>
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<td>Right</td>
<td>R</td>
<td>2y</td>
<td>MB</td>
<td>5th</td>
<td>II</td>
<td>YES</td>
<td>4y</td>
</tr>
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<td>P22</td>
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<td>Right</td>
<td>L</td>
<td>2y</td>
<td>MB</td>
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<td>II</td>
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<td>NR</td>
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<tr>
<td>P23</td>
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<td>Right</td>
<td>L</td>
<td>2y</td>
<td>PB</td>
<td>23</td>
<td>II</td>
<td>NO</td>
<td>NR</td>
</tr>
</tbody>
</table>
Results

In the present study, 23 subjects were analyzed (18 from Santa Marcelina Hospital and five from HUCFF/UFRJ), including 13 (56·5%) male and 10 (44·5%) female patients, with average age of 46·2 years old. The operational classification of leprosy cases was mainly multibacillary (MB), as classified in 19 (83%) subjects and paucibacillary (PB) in four (17%) subjects. The average post-operative time was 6·3 years, with a minimum period of 1 year and a maximum of 23 years. All subjects were right-handed and 14 (61%) had been operated on their dominant hand. Eighty-two percent of the studied patients had already undergone neurolysis of ulnar and median and all had G2D of the hand at the time of the reconstructive surgery (Table 1). Regarding the type of surgery, among those performed in HUCFF/UFRJ, three were made by the Bunnell-Brand technique (two men and one woman), and two by the Zancolli technique (one man and one woman). For 18 patients who underwent surgery at Santa Marcelina Hospital, Zancolli technique was chosen.

SALSA SCALE

For the total score of the SALSA scale and the score specifically for the three domains related to the hand, 22 subjects were considered; the results are displayed in Table 2.

DASH QUESTIONNAIRE

The DASH questionnaire was used to analyse 22 subjects (one missing). The average score was 24·25 ± 18·6, revealing that patients had the impression of good functionality of their upper limb after surgery.

JEBSN TAYLOR’S TEST

When compared with the average means of the reference values of normal subjects, the mean of 23 subjects in the sample for the six tasks differed significantly between them. Therefore, even after surgery, patients in the sample had longer and slower times for performing the same task, when compared with values for healthy subjects \( p < 0·05 \), Table 3.

The 14 patients who underwent surgery on the right hand (dominant), when compared with the reference values for the dominant hand, had longer duration for all evaluated tasks \( p < 0·05 \), Figure 2.

Table 2. SALSA scale – results for total score and hand score

<table>
<thead>
<tr>
<th>Limitation activity degree (Total score)</th>
<th>TOTAL</th>
<th>Degree of limitation on hand activity (Hand score)</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>n</td>
<td>%</td>
<td>n</td>
</tr>
<tr>
<td>No limitation (0–24)</td>
<td>4</td>
<td>18</td>
<td>9</td>
</tr>
<tr>
<td>Light limitation (25–39)</td>
<td>9</td>
<td>41</td>
<td>11</td>
</tr>
<tr>
<td>Moderate limitation (40–49)</td>
<td>8</td>
<td>36</td>
<td>2</td>
</tr>
<tr>
<td>Severe limitation (50–59)</td>
<td>1</td>
<td>5</td>
<td>0</td>
</tr>
<tr>
<td>Very severe limitation (60–80)</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
When comparing the nine patients who underwent surgery in the left hand (non-dominant hand) with the reference values for normal subjects for the non-dominant hand, a greater proximity between means was observed, yet still, significantly different ($p < 0.05$), with the patients being slower than normal subjects (Figure 3).

**Discussion**

The WHO recommends early diagnosis and treatment with MDT as a strategy to prevent physical disability. However, despite therapeutic resources, such as MDT, corticosteroids and neurolysis, a considerable number of cases of ulnar claw with G2D can still be found. This deformity can be already present at diagnosis (late) or can develop later.

Deepak$^{21}$ found a high prevalence of G2D in international surveys, ranging from 17% to 50% after discharge. There are different studies on the prevalence of disabilities in Brazil.$^{22}$ Invariably, the proportion of patients with some physical incapacity remains between 20%

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**Table 3.** Time in seconds of Jepsen Taylor’s test for operated hand – subjects average versus reference values

<table>
<thead>
<tr>
<th>Tasks</th>
<th>Subjects average</th>
<th>Ref. values</th>
<th>t-test sample</th>
<th>p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cards (T2)</td>
<td>9.43 ± 4.2</td>
<td>4.0 ± 0.9</td>
<td></td>
<td>$p &lt; 0.05^*$</td>
</tr>
<tr>
<td>Small objects (T3)</td>
<td>13.3 ± 5.6</td>
<td>5.9 ± 1.0</td>
<td></td>
<td>$p &lt; 0.05^*$</td>
</tr>
<tr>
<td>Simulating alimentation (T4)</td>
<td>12.3 ± 3.0</td>
<td>6.4 ± 0.9</td>
<td></td>
<td>$p &lt; 0.05^*$</td>
</tr>
<tr>
<td>Stacking checkers (T5)</td>
<td>10.1 ± 4.3</td>
<td>3.3 ± 0.7</td>
<td></td>
<td>$p &lt; 0.05^*$</td>
</tr>
<tr>
<td>Big and light objects (T6)</td>
<td>6.4 ± 1.4</td>
<td>3.0 ± 0.4</td>
<td></td>
<td>$p &lt; 0.05^*$</td>
</tr>
<tr>
<td>Big and heavy objects (T7)</td>
<td>6.3 ± 1.4</td>
<td>3.0 ± 0.5</td>
<td></td>
<td>$p &lt; 0.05^*$</td>
</tr>
</tbody>
</table>

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**Figure 2.** Time in seconds for executing six tasks of the Jepsen Taylor’s test, comparing subjects who operated the right hand with reference values for the dominant hand.
These data justify investment in the area of reconstructive surgery and, therefore, this work. The involvement of the economically active population has also been observed in other studies. Thirty-three percent of participants of this study were between 18 and 40 years of age. The disability caused by physical impairment in adults during their productive age causes economic loss, generates psychological trauma and contributes to worsening of stigma, since it is a cause of social exclusion and restrictions of participation.23

For those cases in which the nerve damage was irreversible and deformities and limitations of activities emerged, the tendon transfer repair surgery is recommended in order to restore the intrinsic function of the hand and correct the claw deformity.

Usually the functional limitation is highlighted only when the disability grading proposed by WHO is considered - rankings based on the absence or presence of sensorimotor changes and deformities in hands, feet and eyes.24 However, the International Classification of Functionality proposes a change in the approach based on the consequences of diseases to one that prioritizes functionality as a health component.25 Thus, the present study proposed to assess the manual function of people living with disabilities caused by leprosy, taking into account the effect of physical disabilities, such as ulnar claw, on the dimension of functional independence and social participation.

In this context, one of the instruments used in the present study to evaluate the functional effectiveness of surgical repair in ulnar claw, the JTT, constituted an objective evaluation of the manual function, adding a quantitative timed test score to the SALSA scale and the DASH questionnaire, which are both qualitative and quantitative. The SALSA scale has been widely used to assess the limitations of activities of people suffering from peripheral neuropathy, particularly diabetes and leprosy, covering aspects such as mobility, self-care, skills and manual labour.26

Considering the operational classification, this research was mainly composed of patients classified as MB (dimorphic and Virchowian at 83%). As this study evaluated patients after

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Figure 3. Time in seconds for executing six tasks of the Jabsen Taylor’s test, comparing subjects who operated the left hand with reference values for the non-dominant hand.
tendon transfer surgery, this composition is due to the fact that neuritis and deformities occur mainly in this part of the disease spectrum. The study also revealed that 82% of the studied patients had already undergone surgery for decompression of the ulnar nerve (neurolysis) nearly 6 years before the tendon transfer surgery when the patient already presented ulnar claw. It is noteworthy that in these cases of late application of surgical decompression, the goal is to remove the patient from the chronic use of corticosteroids and associated risks, as well as to relieve chronic pain. Neurolysis, when used in an early stage, is intended to abate nerve damage and its progression to disability.

The assessment of functional disabilities through the SALSA scale corroborates the importance of investigating the levels of activity and social participation of the patient, despite his disability, as recommended by the International Classification of Functioning. The results of the SALSA total score revealed that 41% had limitations from moderate to very severe. The specific analysis of items regarding the hand in the SALSA scale proved to be a more appropriate analysis of the functional hand limitation.

The results of the DASH questionnaire revealed the impression of disability in upper limb from the perspective of the post-surgical ulnar claw correction patients. The average score of the evaluated patients revealed that patients mostly have an impression of a good functionality of the upper limb after surgery. This subjective functionality analysis, as well as SALSA, was enriched by the objective assessment of JTT.

Despite the fact that the JTT was originally developed to evaluate the function of the paretic hand in cases of cerebrovascular accident, it demonstrated to be adaptive and easily applied to evaluate disability due to leprosy. Melchior (2007) performed a study using the same test for the evaluation of patients with leprosy sequelae. Her results were similar to those found in our study, where patients had longer mean times when compared with the reference values of healthy subjects in six evaluated tasks, both for those who had surgery to the dominant hand (100% right-handed) and for those who had surgery on their left hand.

Data from this trial add an objective value to disability data already evidenced by the results of the DASH questionnaire and SALSA scale. Although the analysis of total scores or in the domain of hand in SALSA scale have shown that most patients have slight or moderate limitations, the results of the processing times of functional tasks in the JTT test showed that patients had longer times than the reference values of healthy subjects. This comparison suggests that the SALSA, a qualitative and quantitative subjective tool, is responsive to express the perception of the patient himself about its functional limitation. However, JTT data analysis, an objective analysis, evidenced a greater functional limitation, unregistered by the SALSA scale, both in total score, as well as in the specific score of hand for manual tasks.

The functional loss evidenced by JTT, even after corrective surgery, can be attributed to several supporting comorbidities of ulnar claw, such as: partial or complete alteration of protective sensation and proprioception of the hand, adaptation of the motor standard of the ulnar claw in the surgical pre-period or even a possible change of handedness. Furthermore, it should be remembered that surgery tries to return only one of the two functions of the intrinsic muscles affected, in this case, the bending function at the metacarpophalangeal joint with the consequent claw deformity correction. The second function, adduction and abduction, cannot be restored, and these movements are known to be important to improve the hand’s dexterity.

Limitations of this study include the absence of pre-surgical functional evaluation of patients, the sample size, which precludes the generalization of results to other populations, and the fact that no clinical features, such as pain, numbness and muscle strength, were...
evaluated. The absence of a control group was not considered to be a limitation considering the study design.

The criteria established by the WHO and by the Ministry of Health based on the regular treatment by MDT does not establish monitoring of possible physical disabilities that could arise in the post-discharge period. In a research study performed in homes of people affected by leprosy in Rio de Janeiro, 60% of physical disabilities developed in the period after MDT discharge without monitoring from health services. It is characteristic, therefore, that the lack of longitudinal follow-up, a fundamental attribute of the Family Health Strategy (FHS), creates an obstacle for the rehabilitation process of leprosy patients.30

The decentralization of control activities for this disease to units of Primary Care allow the early detection of disability, facilitating access to a line of care, under the responsibility of the Family Health team.

Monitoring these patients in specialised physical rehabilitation centers (secondary level of care), can possibly lead to delays in evaluation, not allowing interventions in a quick and effective way, which would enable the interruption of the disability progression.

Data from this study show a good understanding of the patient regarding the functionality of the hand after reconstructive surgery for ulnar claw. The evaluated patients exhibited a mild disability according to the scores of the SALSA scale and the DASH questionnaire.

The JTT revealed that patients continue taking more time for executing everyday tasks when compared with normal subjects. The scales and the JTT were easily applied and useful to measure the hand’s functional capacity of the evaluated patients subjectively and objectively.

The fact that the majority of the sample population continued to have some degree of limitation, even after reconstructive surgery, reinforces the importance of early diagnosis of acute neuritis for immediate treatment with corticosteroid therapy and possible surgical interventions, considered to be preventive to nerve damage (neurolysis) in the absence of response of this therapy, thus preventing the onset of the disability.

The perception of functional improvement seen in patients reveals that preventive and remedial surgery in leprosy should be an important investment in leprosy programs.

References

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