

Reconstructive Surgery Prioritization for Hand Deformity in Leprosy Patients: A Cross-sectional Study in Southeast Indonesia

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Leprosy is a neglected tropical disease that can cause severe deformities and disability, particularly affecting the face and extremities. In resource-limited settings such as Southeastern Indonesia, surgical interventions must be carefully prioritized to maximize functional benefit. This study aimed to support surgical prioritization for neuropathies and hand disabilities in leprosy patients by evaluating activity limitation based on specific nerve involvement. A cross-sectional study was conducted in July 2023 among all inpatients at Naob Leprosy Hospital, Timor Tengah Utara, Nusa Tenggara Timur. All patients were assessed using the Screening of Activity Limitation and Safety Awareness (SALSA) score and underwent physical examination to evaluate motor impairment of the ulnar, radial, and median nerves. A total of 41 patients (35 males, 6 females; aged 14–78 years) were included. Ulnar nerve impairment was most common (51.22%), followed by median (43.90%) and radial nerve impairment (29.27%). SALSA scores ranged from 14 to 45 and were higher in patients with nerve impairment. However, only median nerve impairment showed a statistically significant association with increased SALSA scores ($p = 0.032$). These findings suggest that surgical prioritization in leprosy-related hand deformities should consider both SALSA scores and nerve involvement, particularly median nerve impairment. Early surgical intervention alongside antimicrobial therapy may help prevent progressive disability and improve functional outcomes.

Keywords: Leprosy, Peripheral Nerve Impairment, SALSA Score, Median Nerve, Surgical Intervention

Introduction

Leprosy, or Morbus Hansen, is a neglected tropical disease caused by chronic infection with *Mycobacterium leprae*, primarily affecting the skin and peripheral nerves (Chen et al

2022). While most countries had achieved the elimination of leprosy as a public health problem by 2010, the World Health Organization (WHO) introduced a new paradigm aiming for the elimination of leprosy disease itself by 2030.

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This goal emphasizes not only the absence of the disease but also the eradication of associated disability, stigma, and discrimination (Control of Neglected Tropical Diseases (NTD) 2024).

Despite the WHO's elimination framework, there was a 5% increase in newly detected cases globally from 2022 to 2023 (Control of Neglected Tropical Diseases (NTD) 2024). Indonesia remains one of the 23 global priority countries, with over 14,000 new cases reported in 2023, ranking third after India and Brazil. The country faces ongoing challenges in achieving leprosy elimination, including late diagnosis, stigma, poor treatment adherence, and difficulties in identifying close contacts (Setiawati 2024).

Previous reviews have reported that disability in leprosy patients is associated with sex, disease classification (paucibacillary or multibacillary), leprosy reactions, and clinical presentation (De Paula et al 2019). In addition to skin lesions, neuropathy is a hallmark of leprosy. It typically presents as thickened peripheral nerves and negative sensory symptoms such as numbness, anhidrosis, and painless wounds (Khadilkar et al 2021). Neuropathy can also lead to muscle weakness and limb deformities, both of which impair daily functioning and contribute to activity limitations. Early diagnosis and treatment are critical to preventing motor nerve impairment in leprosy.

Studies show that over 40% of outpatient leprosy patients exhibit hand disabilities due to involvement of the ulnar, radial, and median nerves (Geani et al 2022, Khadilkar et al 2021). Nerve thickening, observed in 40–75% of patients, is not only a cardinal sign of leprosy but also reflects the underlying pathophysiology of leprosy-related neuropathy. This thickening results from the proliferation of periaxonal Schwann cells and perineural cells (Khadilkar et al 2015).

In resource-limited settings such as Southeastern Indonesia, surgeons must prioritize interventions that offer the greatest benefit. Therefore, prioritizing surgical intervention on a single anatomical site based on activity limitation assessment is crucial for surgical planning in limited resources. However, we found limited literature related to this topic.

So, this study aimed to evaluate activity limitations (using the SALSA score) in leprosy patients with hand deformities in relation to the three peripheral nerves responsible for hand function. It is hoped that the findings will support prioritizing surgical interventions for neuropathies and hand disabilities in resource-constrained areas.

Methods

Study type and sample identification

This study employed a cross-sectional analytic design to evaluate the physical disability and functional limitation differences among the anatomical distributions of nerve impairment in leprosy patients. The cross-sectional approach was chosen to capture a snapshot of disability status and related factors at a single point in time, allowing the identification of patterns relevant to surgical prioritization in resource-constrained settings.

Participants were recruited using total sampling from an inpatient registry of individuals diagnosed with leprosy in Naob Leprosy Hospital, Timor Tengah Utara Regency, Nusa Tenggara Timur, in July 2023. Therefore, no formal sample size calculation was performed. Exclusion criteria were cognitive impairment or a communication barrier that interferes with the screening of activity limitation and safety awareness (SALSA) question interview, and refusal of participation in the study.

An ethical clearance was obtained from the

Health Research Ethics Committee, Faculty of Medicine and Veterinary Medicine, Universitas Nusa Cendana (Approval No: 40/UN15.16/KEPK/2023). The study followed STROBE guideline checklist for cross-sectional study.

Data Collection and Statistical Analysis

Data were collected through a combination of clinical examination, structured interviews, and standardized scoring tools. The impairment status of the hands was based on the involvement of either the radial, ulnar, or median nerves. Ulnar nerve impairment was assessed based on the strength of index finger abduction. Median nerve impairment was evaluated by examining the strength of thumb abduction and thumb opposition. Radial nerve impairment was determined by assessing the strength of wrist extension.

The SALSA questionnaire was used to assess the functional limitations experienced by individuals in their daily activities. The SALSA scale, a validated tool widely used in leprosy and other neuropathic conditions, includes a questionnaire covering domains such as mobility, self-care, work, dexterity, and safety awareness (Ebenso et al 2004, 2010; The Salsa Collaborative Study Group 2007). To limit practice variability, we used the standardized Indonesian version of the SALSA score (obtained from <http://www.infontd.org>).

The SALSA questionnaire consists of 20 questions of daily functioning related to three domains: mobility, self-care, and work (Appendix 1). The score ranges from 0 to 80, with the following classification: no limitation (0-24), mild limitation (25-39), moderate limitation (40-49), severe limitation (50-59), and extreme limitation (60-80) (Ebenso et al 2004, 2010; The Salsa Collaborative Study Group 2007).

Basic sociodemographic data, including age, sex, and educational level, were also obtained

through interviews with participants or review of medical records. All clinical evaluations were performed by trained medical personnel familiar with the SALSA questionnaire administration.

Microsoft Excel software was used to compile, organize, and clean raw data. The chi-square test was employed in analyzing the age mean difference. The mean SALSA scores between the impaired and non-impaired subjects were analyzed using an independent sample T-test. The p-value of less than 0.05 is considered significant. Statistical analyses were conducted using the GNU PSPP version 1.4.1 (Free Software Foundation, Boston, USA; <https://ftp.gnu.org>). Because total sampling of all eligible inpatients was applied, no weighting or adjustment for sampling strategy was required in the analysis. Artificial intelligence (AI) tools (QuillBot, ChatGPT) were used only for grammatical correction of this manuscript.

Results

A total of 41 subjects (35 males and 6 females) aged 14 to 78 years were involved in this analysis, with 1 participant excluded due to pain during the sensory assessment. The mean age of male and female patients was 41.91 ($\pm$ 17.74) and 37.33 ($\pm$ 12.50) years, respectively. There was no statistical significant difference between the ages of male and female patients ($p = 0.549$). The summary of characteristics of participants, nerve impairment, and SALSA score were presented in Table 1 whereas the details of impairment in each nerve is presented in Table 2.

SALSA scores ranged from 14 to 45. The mean SALSA score in each impaired nerve group was consistent with mild limitation. While SALSA scores in both groups remained within the mild limitation category, subjects with median nerve impairment had significantly higher scores than those without impairment ($p = 0.032$), as presented in Table 3.

Table 1: Baseline characteristics of participants.

Characteristics		n (%)
Sex	Male	35 (85.37)
	Female	6 (14.63)
Educational background	Uneducated	8 (19.51)
	Primary education	17 (41.46)
	Secondary education	11 (26.83)
	Tertiary education	5 (12.20)
Nerve impairment location	Ulnar	21 (51.22)
	Median	18 (43.90)
	Radial	12 (29.27)
Leprosy type	Paucibacillary	1 (2.44)
	Multibacillary	40 (97.56)
SALSA score	No limitations (0-24)	26 (63.41)
	Mild limitations (25-39)	13 (31.71)
	Moderate limitations (40-49)	2 (4.88)

Table 2 : Details of impairment of various nerves.

Nerve	Impaired		Not Impaired	
	Right n (%)	Left n (%)	Right n (%)	Left n (%)
Ulnar Nerve Index finger abduction	17 (41.5)	17 (41.5)	24 (58.5)	24 (58.5)
Median Nerve Thumb adduction	12 (29.3)	15 (36.6)	29 (70.7)	26 (63.4)
Median Nerve Thumb opposition	8 (19.5)	11 (26.8)	33 (80.5)	30 (73.2)
Radial Nerve Wrist extension	6 (14.6)	11 (26.8)	35 (85.4)	30 (73.2)

Table 3: Independent sample T-test results for mean SALSA score based on nerve impairment site.

Location	Mean SALSA score		p-value
	Impaired	Not impaired	
Radial nerve	26.58 (n=12)	22.48 (n=29)	0.143
Median nerve	26.72 (n=18)	21.30 (n=23)	0.032
Ulnar nerve	25.43 (n=21)	21.85 (n=20)	0.549

Appendix 1. SALSA Score Questions (Ebenso et al 2004)

SALSA Scale		If Yes, how easy is it for you?			If No, why not?		
Screening of Activity Limitation & Safety Awareness		Easy	A little difficult	Very difficult	I don't need to do this	I physically cannot	I avoid because of risk
Tick one box on each line in response to each question.							
1	Can you see (enough to carry out your daily activities)?	1	2	3		4	
2	Do you sit or squat on the ground?	1	2	3	0	4	4
3	Do you walk barefoot? e.g. most of the time	1	2	3	0	④	④
4	Do you walk on uneven ground?	1	2	3	0	④	④
5	Do you walk longer distances? i.e. longer than 30 minutes	1	2	3	0	④	④
6	Do you wash your whole body? (using soap, sponge, jug; standing or sitting....)	1	2	3	0	4	4
7	Do you cut your finger or toenails? e.g. using scissors or clippers...	1	2	3	0	④	④
8	Do you hold a cup or basin with hot contents? e.g. drinks, food ...	1	2	3	0	4	4
9	Do you work with tools? i.e. tools which you hold in your hands to help you work ...	1	2	3	0	④	④
10	Do you carry heavy objects or bags? e.g. shopping, food, water, wood ...	1	2	3	0	④	④
11	Do you lift objects above your head? e.g. to place on a shelf, on your head, to hang clothes to dry ...	1	2	3	0	④	④
12	Do you cook? i.e. prepare food both hot and cold	1	2	3	0	④	④
13	Do you pour hot liquids?	1	2	3	0	④	④

14	Do you open/close screw capped bottles? e.g. oil, water..	1	2	3	0	4	4
15	Do you open jars with screw-on lids? e.g. jam...	1	2	3	0	④	④
16	Do you handle or manipulate small objects? e.g. coins, nails, small screws, grains and seeds ...	1	2	3	0	4	4
17	Do you use buttons? e.g. buttons on clothing, bags...	1	2	3	0	4	4
18	Do you thread needles? i.e. pass thread through the eye of a needle	1	2	3	0	④	④
19	Do you pick up pieces of paper, handle paper or put it in order?	1	2	3	0	4	4
20	Do you pick up things from the floor?	1	2	3	0	4	4
Subtotal scores(add up the column)		(S1)	(S2)	(S3)	(S4)	(S5)	(S6)
SALSA score (add up all subtotal scores))		(S1+S2+S3+S4+S5+S6)					

Discussion

Hand deformities in leprosy patients are not only anatomical matters but also deeply functional. It is one kind of clinical complication in leprosy patients and is a long-term disability with high morbidity due to prolonged motor nerve impairment. Involvement of motor nerves in the hand causes muscle paralysis, deformity, and disruption of the normal physiology of the hand (Calderone et al 2024). This condition not only decreases patients' quality of life but also induces a "double stigma" in society (Pratiwi et al 2025, Rusnah et al 2025).

Double stigma refers to the combined presence of internal and social stigma. Internal stigma stems from an individual's negative self-image and emotional reaction to their condition, while social stigma is driven by societal misconceptions,

prejudice, and discriminatory attitudes toward people affected by leprosy (Rusnah et al 2025). However, the most common problem in resource-constrained areas is that there is an unbalanced ratio of patients needing surgery and the availability of surgeons. An effective prioritization approach is needed to establish the most impactful use of available clinical services.

According to our study results, male patients predominate but no significant age difference between male and female patients was observed. This finding indicates that, within this study population, age may not be a confounding factor in the observed sex-related differences in disease severity or disability outcomes. The majority of the subjects (60.97%) had a low educational level, either having only completed elementary education or being uneducated, representing

the socio-economic background of the study population. The people with lower educational and socio-economic backgrounds may describe the late in seeking help from the healthcare provider.

Most of our subjects were classified as multibacillary (MB) type of leprosy (97.56%), consistent with a previous study conducted by Samosir et al. in Indonesia (Samosir et al 2023). Multibacillary leprosy is characterized by a higher bacterial load and larger lesion distribution, which leads to more severe nerve involvement. This form of leprosy is typically associated with a leprosy reaction that exacerbates nerve inflammation and damage, thus making it at a higher risk of physical disability (Bandeira et al 2024, Nery et al 2019).

The dominance of the MB type in our study may also be explained by the interaction between sex and socioeconomic factors. Several previous studies reported a tendency for male patients to experience more severe disability due to delayed diagnosis and high physical work exposure, which are strongly associated with MB type and a higher risk of disability (Chen et al 2021, De Paula et al 2019, Rathod et al 2020). Low educational level also associated with poor awareness and delayed health care access, both can contribute to MB type leprosy, as reported by a previous study (Serra et al 2019).

The Screening of Activity Limitation and Safety Awareness (SALSA) scale is a widely used subjective questionnaire to evaluate both activity limitations and safety awareness. A previous study in Indonesia found that SALSA scores were most strongly associated with foot disability, followed by occupational status, eye impairment, and age (Menaldi et al 2022). In leprosy patients, activity limitations and safety awareness are related to hand deformities, which are primarily linked to impairment of the ulnar, median, and

radial nerves. These nerves are relatively easy to examine, and their dysfunction often results in severe, disabling impairments.

We hypothesized that functional limitation, as evaluated by the SALSA score, correlates with specific clinical hand findings and the anatomical site of nerve impairment in patients with leprosy. Our reported outcome showed that a statistically significant higher SALSA score was noted only in subjects with median nerve impairment ($p=0.032$). Interestingly, although the ulnar nerve was the most frequently impaired (51.22%), the median nerve, which was the second most predominantly impaired (43.90%), was the only nerve associated with a significantly higher SALSA score. This finding means median nerve impairment may contribute to more dysfunction in their activities of daily living (ADL).

The median nerve is one of the primary nerves that innervates the hand to establish most of its functions. It is known to play an important role in fine motor function, grip strength, and sensory control of the radial area of the hand, including the thumb, index finger, and middle finger (Soubeyrand et al 2020). As a result, damage to this nerve has a direct impact on the patient's ability to perform daily activities such as eating, writing, and dressing. The median nerve impairment usually manifests as a "wrist problem," and the clinical features are similar to carpal tunnel syndrome (CTS). The presence of nerve thickening is the hallmark of median nerve impairment caused by leprosy, which differentiates from CTS (Alves et al 2024). Considering these findings, median nerve damage can be used as an important indicator in determining the priority of the need for hand reconstructive surgery, especially in areas with limited medical and surgical resources.

Therefore, decision-making for the priority of hand surgery in leprosy patients needs to

consider a combination of the SALSA score and the anatomical location of the affected nerve—especially median nerve impairment. These are simple, cost-effective, and evidence-based tools to use because basic history taking and physical examinations are all that is needed.

Surgical intervention provides not only a permanent restoration for the leprosy impairment or deformities but also impairment prevention. Surgical decompression is one of the surgical techniques that releases a compressed nerve, which is used to conserve the normal neural and vascular function to prevent ischemia. It can also benefit from preventing dependency on steroids and cutting off stigmatization through disability prevention (Husain & Mishra 2008, Wan et al 2016). A study, comparing long-term outcomes between steroid-only (group A) and combined steroid with surgical decompression (group B), reported that there was a more rapid and complete improvement of both sensory and motor strength in group B (Sajid et al 2021). It showed that early surgical intervention, at the right time, provides better outcomes for the patients.

Based on this study outcome, integrating clinical, functional, and anatomical perspectives, especially in resource-constrained areas, should be considered as a tool to help prioritize patients for surgical intervention. Thus, early adjunctive intervention, such as surgical decompression for patients presenting with such criteria, is needed to achieve a better prognosis.

The main strength of this study is its implementation in a resource-limited area, hence providing data that is relevant and applicable to real conditions. By using a local population that is often underrepresented in research, this study can accurately describe the needs and challenges of surgical services in a remote area. In addition, the data-driven approach used in establishing

surgical priorities provides a real contribution to fairer and more efficient decision-making in a resource-constrained area. The findings of this study are not only useful locally but also have the potential to be replicated or adapted in other areas with similar conditions.

Nonetheless, some limitations exist, such as a limited sample size and potential selection bias, as only patients who were registered or had access to the health facility may limit the representativeness of the results. Variations in clinical judgment by health care providers may also affect data consistency. Finally, the resulting prioritization model requires further external validation before it can be widely applied in other regions.

Conclusion

The decision-making for the priority of hand surgery in leprosy patients needs to consider a combination of the SALSA score and the anatomical location of the affected nerve—especially median nerve impairment. Thus, we recommend early surgical intervention, such as surgical decompression for patients presenting with such criteria, is needed to achieve a better prognosis, as adjunctive to routine antimicrobial regimens and steroids. Further large-scale studies with external validation are required before the findings can be fully applied in clinical practice.

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