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Orthopedic approach of the leprous foot

by Thiago Batista Faleiro[1*], Gildásio de Cerqueira Daltro[2], Alex Guedes[3], Renata da Silva Schulz[4], Jorge Eduardo de Schoucair Jambeiro[5], Maria Betânia Pereira Toralles[6]

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Leprosy is a disease known for thousands of years with pathophysiology and treatment established for decades. Nevertheless, there are still cases of delayed diagnosis and poor monitoring of previously diagnosed patients. The combination of deformity and insensitivity in the feet is responsible for severe functional limitations and the formation of ulcers that evolve to amputation. Knowledge of the natural history of foot in leprosy contributes to the adoption of therapeutic measures in a timely manner in order to ensure better quality of life to the patient.

Keywords: Leprosy; orthopedic procedures; foot deformities

Leprosy is an infectious, contagious and curable disease caused by *Mycobacterium leprae* whose major route of infection is respiratory mainly transmitted by untreated multibacillary patients. It is considered a multisystemic infection affecting the skin and peripheral nerves [8]. Currently, 80% of new cases are concentrated in countries located in the intertropical band: India, Brazil, Myanmar, Madagascar, Nepal and Mozambique [18]. In 2011, the prevalence rate was 1.24 per 10,000 inhabitants in Brazil [15].

1-Titular Member, Brazilian Society of Ortopedia and Traumatology (SBOT). Titular Member of the Brazilian Association of Medicine and Surgery of the Ankle and Foot. E-mail: thiagofaleiro@yahoo.com.br
2-Titular Member, Brazilian Society of Ortopedia and Traumatology (SBOT). Titular Professor - Lecturer, Department of Experimental Surgery and Surgical Specialties (DCEEC), Faculty of Medicine of Bahia (FMB), Federal University of Bahia (UFBA). E-mail: gildasio.daltro@yahoo.com.br
3-Titular Member, Brazilian Society of Ortopedia and Traumatology (SBOT). Adjunct Professor - Doctor, Department of Experimental Surgery and Surgical Specialties (DCEEC), Faculty of Medicine of Bahia (FMB), Federal University of Bahia (UFBA). E-mail: alexguedes2003@yahoo.com.br
4-Nurse Specialist in Clinical Surgery by the State University of Rio de Janeiro (UERJ), Master in Nursing by the Fluminense Federal University (UFF). E-mail: renata.s.schulz@gmail.com
5-Full Member, Orthopedics and Traumatology Brazilian Society (SBOT). Member of the Brazilian Surgery and Foot and Ankle Medical Association. Head of Foot and Ankle Surgery Group of the University Hospital Santa Isabel, Salvador, Bahia, Brazil
6-Medical, Clinical Genetics Course Professor, Faculty of Medicine of Bahia (FMB), Federal University of Bahia (UFBA). Salvador, Bahia, Brazil
* - correspondence: thiagofaleiro@yahoo.com.br

Damage on the peripheral nervous system before, during and even after the end of treatment, that is, after the end of the specific therapy (multidrug therapy) is responsible for most of the deficits and deformities associated with leprosy [13]. The diagnosis and treatment of neuritis should be carried out early, as these are the main factors for preventing such complications. Neurites under six months of evolution respond best to corticotherapy [30]. On lower limb, lesions of the common peroneal and posterior tibial nerves are the most common, found in 79 and 82% of cases, respectively [11]. Nerve damage causes changes in tactile sensitivity and proprioception, making it particularly susceptible to trauma and limb muscle weakness, generating physical deformity. These changes need to be diagnosed and treated early in order to prevent permanent disability and emotional sequelae in infected individuals [17]. In a study conducted in Turkey [4], the prevalence of disability by the involvement of the feet was 73.3%, among which 19.8% had plantar insensitivity and 37.2% had plantar ulcers. Patients affected by leprosy have limitations related to reduced ability to walk and to the severity of involvement of the feet [28]. The natural evolution of leprosy can be didactically presented as shown in the left column of Figure 1. The recommended treatment for each phase of the disease is in the right column of Figure 1.

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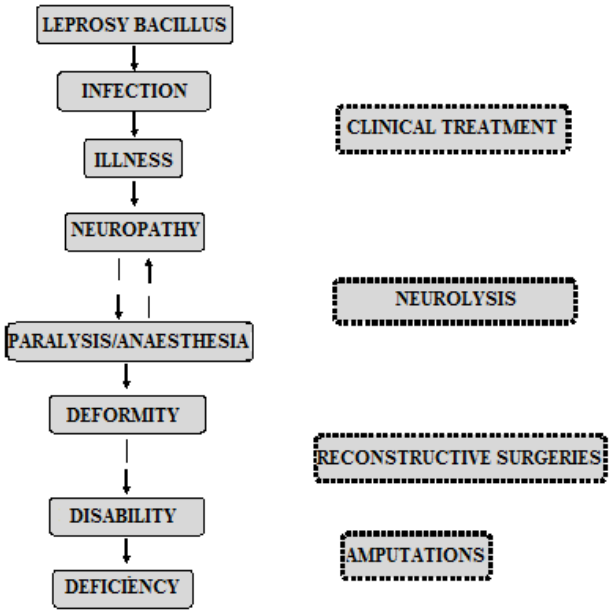

Figure 1 Left column: sequence of pathological events leading to disability in leprosy; Right column: recommended treatment for each phase of the progression of the disease.

Although known for thousands of years and with established pathophysiology and therapeutics, there is still a delay in the diagnosis of leprosy, particularly given the long incubation period of the disease which is (often) asymptomatic, its insidious character and the lack of preparation by health professionals [27]. The objective of the present review is to address the most important aspects related to orthopedic approach to the involvement of the feet in leprosy.

Diagnosis

The diagnosis of leprosy in the majority of the Brazil states is still delayed, happening between one and half to two years after the first symptoms [1]. In Brazil, 5.7% of diagnosed patients already have sensory and/or motor lesions and deformities, all preventable [24].

The Ministry of Health [21] defines the diagnosis of leprosy through the presence of one or more of the following criteria:

1. Skin Injury (ies) with altered sensitivity;
2. Neurological involvement with neural thickening;
3. Positive bacilloscopy.

Thus, performing sensitivity tests, palpation of accessible nerve trunks and evaluation of functional neurology (sensory, motor and autonomic) is required for diagnosis of leprosy.

Search for cutaneous sensitivity (thermal) - the first to be compromised -, pain sensitivity and tactile sensitivity - the last to diminish and disappear-, is performed. When in doubt, additional tests are done, such as histamine and pilocarpine tests [2].

Physical examination should begin by careful ectoscopy for changes, ulcers or deformities in the skin. Also, it is important to check the active and passive joint mobility as well as the degree of muscle strength in different related segments (Table 1).

Palpation of nerve trunks should seek to check for increased volume or pain and paraesthesia. In the case of the common peroneal nerve, the patient must keep the legs hanging; the nerve must be palpated on the posterior surface of the fibula at the level of the lap. The tibial nerve must be palpated with the foot kept in passive inversion and plantar flexion, posterior to the medial malleolus [22].

Leprous Neuropathy

In nerve trunks, millions of Mycobacterium leprae spread around each compartment and layer of nerves, initially without any apparent tissue reaction. There is usually some swelling, but with time the proliferation of fibroblasts will create diffuse cicatrisation in the nerve and finally complete fibrosis and loss of function. This process may take years to be completed and it is observed in almost all peripheral nerves, from proximities the spinal cord to the periphery [30].

The treatment of acute neuritis (painful or silent) is initially conservative with prescription of corticosteroids, being prednisone the most frequently used. This is applied with a loading dose of 1 to 2 mg/kg/day according to the severity of the case. This dose should be maintained until regression of signs and symptoms, followed by weaning phase, which must be done slowly and gradually over a period of at least six months [26].

This process gives rise to intrinsic and extrinsic neural compression developed in three basic stages: irritative (stage I) - characterized by pain, paresthesia and hyperesthesia; compressive (stage II) - characterized by hypoesthesia and paresthesia; and deficit (stage III) - characterized by anesthesia, paralysis and atrophy. Surgical treatment (external neurolysis) in stages II and III is considered the alternative that allows the most promising results, particularly in stage II in which the patient may experience reversion of wholly or partially sensory-motor loss. At stage III, external neurolysis inhibits the intraneural degenerative process; however, clinical regression will rarely happen, making it necessary to associate it with operations of rehabilitative nature [14].

Neurolysis consists in the release of the nerve trunk of anatomical areas under anguish, reducing the edema, inflammation and intraneural compression. Its indications are not well defined in the literature [31]. The following criteria are used in Brazil [20]:

1. Contraindication to the use of nerve abscess corticoids;
2. Refractoriness to clinical treatment after four weeks;
3. Subintrant neuritis or neuropathy (after three episodes);
4. Non-treatable or chronic pain;
5. Neuritis of the posterior tibial.

Neuritis of the posterior tibial nerve, often silent, does not respond well to treatment with corticoids. Decompression of the nerve trunk can be indicated either as preventing the plantar perforating illness (in cases presenting early signs and symptoms of neuropathy), as a therapeutic intervention (in cases with signs and symptoms of fully established tibial lesion) [29] (Figure 2A and B).

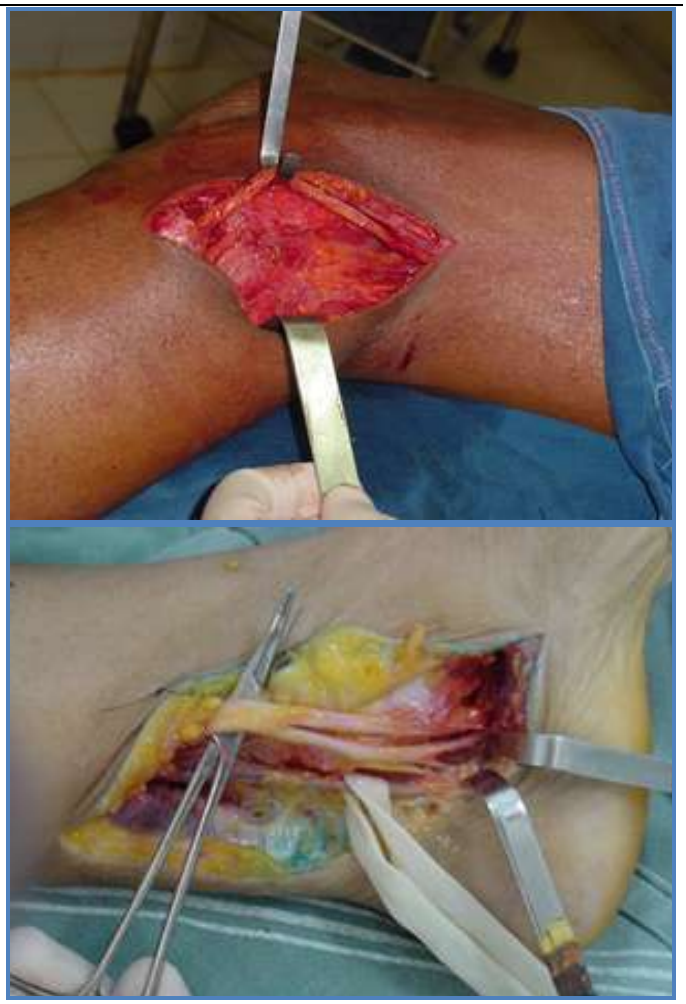

Figure 2 Neurolysis of the peroneal and tibial nerves, respectively.

Treatment of "Footdrop"

Among the deformities caused by the injury of the common peroneal and posterior tibial nerves, we found the equinovarus foot and, less frequently, the equine foot. The first deformity, equinovarus foot, the more serious, is the result of paralysis or paresis of important dorsiflexor muscles and foot eversion as a result of damage to the superficial and deep branches of the common peroneal nerve, located in the height of the lap of the fibula. Also important, the second deformity is due to paralysis or paresis of the dorsiflexor muscles consequent only of injury of the deep branch [25]. As a result, the patient loses the ability to elevate her foot during march. This corresponds to the so-called footdrop and slapping gait, very disabling, which may cause damage to the plantar region and induce rigid foot deformities. The transfer technique of posterior tibial muscle to correct

these deficiencies was described by Brand [3] and is now the most used operative modality.

"Claw" Toes

The intrinsic muscles of the foot maintain their structure while walking and thus regulate the mechanics and the distribution of loads on the march. When intrinsic muscles are paralyzed due to neuropathy of the tibial nerve, as in leprosy patients, there is a high prevalence of plantar ulceration and deformities, especially when muscle weakness is associated with loss of sensitivity [34]. The typical deformity of neuropathic feet consists in "claw" toes (Figure 3), which can be divided into two types [23]:

1. Mobile: when it is possible to passively move the metatarsophalangeal and interphalangeal joints;
2. Rigid: when the joints are in a rigid position and there is no passive correction of the deformity.

Figure 3 Clinical aspect of a patient with "claw" toes deformity.

In the case of toes with flexible "claws", the transfer of the flexor digitorum longus to the extensor apparatus, described by Girdlestone-Parrish, is a useful mean for correction. Although satisfaction varies in the literature, this technique remains a useful tool in the surgeon's arsenal to treat the deformity, decrease pain and help to prevent ulcers [16].

In cases of rigid "claw" toes, often associated with joint degeneration, surgical treatment involves arthrodesis or resection arthroplasty. The proximal interphalangeal arthrodesis has several advantages including reduced risk of recurrence and more predictable posture of the foot [10]. However, loss of mobility can predispose to ulcer formation. Thus, resection arthroplasty should be considered as the best therapeutic option for smaller toes in insensitive feet.

Plantar Ulcers

The plantar region is often center of ulcers due to biomechanical changes and decreased sensitivity. Muscular atrophy, muscle weakness and deformities alter the biomechanics, contributing to foot bone disorder. This makes the patient execute maladjusted march, causing new pressure points. Furthermore, leprosy patients have decreased or abolished sensitivity with consequent decrease in the physiological protection needed to prevent cutaneous lesions [5].

The feet are characterized as the most commonly affected site by skin ulcers (52% of cases) often in individuals who have disability classified in stage II and positive bacilloscopy as detected by spectral and operational classifications [12].

Conservative treatment of plantar ulcers should be instituted as early as possible. Success rates as high as 98% are possible with use of accelerators such as alginate, hydrocolloid and collagen, developed to fit the physiology and the needs of the healing of wounds [6]. The use of orthoses can reduce the time of wound healing [7].

In cases where the conservative treatment fails, it is necessary the introduction of surgical treatment, which must meet five objectives [33]:

1. Removal of infectious foci, such as sequestration;
2. Removal of localized bony prominences, which can cause ulceration;
3. Bone realignment to produce a more functional unit;
4. Reduce the excessive mobility (through osteotomies and arthrodesis);
5. Stabilization in motor neuropathy (tendon transfer, tenodesis or arthrodesis).

Amputations

Amputation removes the damaged segment, but must provide residual stump eligible to receive prosthesis, allowing the patient to ambulate for the rest of his life. A fundamental principle in the management of these patients is the need for constant observation for the presence of wounds or sores on the stump, proper gait training and a well-built prosthesis [9].

Among leprosy patients, the main causes for amputation are complicated chronic ulcers with infection who develop osteomyelitis and bone resorption [19]. All amputation levels are used in leprosy patient surgery. The criterion of choice is the same used in amputations for other reasons: the surgeon must select the most distal amputation level possible based on pathology, preoperative functional demands and intraoperative finding [32].

Conclusion

The leprous neuropathy constitutes a major operative challenge for foot and ankle surgeon for two main reasons: the diversity of techniques - the necessary domain - and the fact that many patients require more than one surgical approach. Still, the best approach is prevention. Early steroids and neurolysis well indicated lead to the goal of a plantigrade and functional foot free of ulcers.

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Nerve	Muscles	Functions	Muscle testing
Common peroneal (deep branch)	Anterior tibial (minimum assessment required)	Dorsiflexion/extension of the foot	Patient in sitting position with the knee in slight flexion or extension (in this case there is a reduction of the movement for the tension of the triceps surae). The examiner stabilizes the leg, holding it above the ankle joint and asks the patient to perform the dorsiflexion of the foot with maximum force, applying opposing force to the instep. Verify muscle contraction.
Common fibular (deep branch)	Extensor of the hallux (minimum assessment required)	Extension of the metatarsophalangeal joint of the hallux	Patient in sitting position, knee in extension. The examiner stabilizes the foot and ankle in a neutral position and asks the patient to make maximum extension of the hallux, applying opposing force to the dorsum of the proximal phalanx of this toe. Verify muscle contraction.
Common fibular (deep branch)	Long extensor of toes	Extension of the metatarsophalangeal joints of the second through fifth toes	Patient in sitting position, knee in extension. The examiner stabilizes the foot and ankle in a neutral position and asks the patient to make maximum extension of toes. The examiner applies opposing force on the back of the proximal phalanges of the second to fifth toes. Verify muscle contraction.
Common peroneal (superficial branch)	Long and short Fibular	Foot eversion	Patient in sitting position, knees extended with the long extensor of the toes relaxed. The examiner stabilizes the ankle joint in neutral position and asks the patient to evert the foot applying opposing force in the lateral border of the fifth metatarsal in order to push it inside. Verify muscle contraction.
Tibial	Abductor of the hallux	Abduction of the hallux and metatarsal-phalangeal flexion	Due to the difficulty of carrying out the proof of intrinsic muscles of the foot, the main change in the clinical examination is the loss of sensation on the region innervated by the tibial.

Table 1 Nerves, innervated muscle groups, their respective functions and muscle tests.