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Clinical, Electrodiagnostic and Pedobarographic Assessments of Leprotic Patients with Trans-Tibial Amputation

[1]Y. Salekzamani, [1]S.K. Shakouri, [1]Y. Houshyar, [1]V. Ghanjeyfar, [2]A. Samarbakhsh,
[2]M. Shamaizadeh and [3,4,5]N. Nezami
[1]Department of Physical Medicine and Rehabilitation, Tabriz University (Medical Sciences), Tabriz, Iran
[2]Faculty of Rehabilitation, Tabriz University (Medical Sciences), Tabriz, Iran
[3]Drug Applied Research Center, Tabriz University (Medical Sciences), Tabriz, Iran
[4]Young Researcher Club, Tabriz Islamic Azad University, Tabriz, Iran
[5]Department of Orthopaedic Surgery, Tabriz University (Medical Sciences), Tabriz, Iran

Abstract: The aim of present study was to investigate clinical, electrodiagnostic and pedobarographic findings of non-amputee limb in chronic leprotic patients with unilateral trans-tibial amputation to determine neuropathy and plantar foot pressure in non-amputee limb. During the present prospective cross-sectional study, 10 chronic leprotic patients with unilateral trans-tibial amputation were evaluated. The study was conducted in Tabriz Bababaghi and Imam Reza Hospitals at summer of 2008. Sensory nerve conduction (SNAP) and Compound Motor Action Potentials (CMAP) studies were performed in association with pedobarographic assessment. No reliable response was detected from tested sensory and motor nerves, except a very low amplitude finding in deep preoneal nerve of one patient. In comparing with healthy group, static total plantar area, dynamic total plantar area, static rarefoot peak pressure and dynamic rarefoot peak pressure were lower in leprotic patients ($p = 0.047$, $p = 0.004$, $p = 0.029$ and $p<0.001$), while static forefoot peak pressure and dynamic forefoot peak pressure were higher in these patients ($p = 0.011$ and $p = 0.031$). All of leprotic patients with unilateral trans-tibial amputation suffered from severe neuropathy. Also, these patients have high plantar pressure under the forefoot. Collectively, severe neuropathy and abnormal plantar foot pressure expose in non-amputee foot expose leprotic patients to the higher risk of secondary amputation.

Key words: Leprosy, nerve conductive velocity, electromyelography, pedobarography, trans-tibial amputation

INTRODUCTION

Leprosy or Hansens disease is a chronic infectious disease caused by mycobacterium leprae and leads to multisystem organ involvement, primarily the skin and peripheral nerves (Lockwood, 2004). Dependent on immune system response, different clinical manifestations of this disease may be presented including polar tuberculosis leprosy (paucibacillary; TT) and polar lepromatous leprosy (multibacillary; LL) (Shetty and Doshi, 2008). Leprosy is one of the main causes of permanent physical disabilities among the communication acquired diseases. This disease and its deformities contribute to stigma results in discrimination of patients (Smith *et al*., 1995). World Health Organization (1996, 2006) estimated that between 2 and 3 million individuals, especially young adults are permanently disabled due to leprosy. Therefore, WHO has been focused to prevent disability and leprosy related stigma in affected individuals. These people need rehabilitation services, but unfortunately only small part of these patients have access to such services. There is an urgent need for operational researches to address coverage and access to basic Prevention of Disability (POD) measures, such as self- care training and footwear. These issues were identified as a top research priority recently (Smith *et al*., 1995; World Health Organization, 2006).

Pedobarography (measurement of foot pressure distribution) is clinically useful method which can diagnosis anatomical foot deformities, diagnosis and guide to treat gait disorders and guide to choose strategies for preventing foot ulcers in neuropathic patients (Rodgers, 1995). Pedobarography is increasingly used in both research and clinical practice to compare gait patterns of different clinical groups and evaluate the effect of footwear, orthotic and surgical intervention

Corresponding Author: Nariman Nezami, Clinical Pharmacy Laboratory, Drug Applied Research Center, Tabriz University (Medical Sciences), Pashmineh, Daneshagh Street, Tabriz, Eastern Azerbaijan, Zip Code 5165665811, Iran Tel: +98 (411) 3311147, +989141130560 Fax: +98(411)3363231

(Orlin and McPoil, 2000). Some researches have studied the pressure patterns in patients with diabetes mellitus and rheumatoid arthritis (Masson *et al*., 1989; Frykberg *et al*., 1998; Caselli *et al*., 2002; Acharya *et al*., 2008).

In leprotic patients, peripheral nerve damage (neuropathy) is one of the common complications that lead to long term morbidity and mortality. The insensitive foot following neuropathy is the most common chronic residual deformity of leprosy. In this condition, any damage to skin barrage becomes a potential port of entry for infectious agents, leading to deep infection and ultimately amputation of organ. Plantar ulceration has been associated with lower extremity peripheral neuropathy and excessive plantar pressures (Boulton *et al*., 1983; Kastenbauer *et al*., 2001). Pressure on the soft tissues of the foot is related to three variables: the force applied to the foot, the surface over which the force applied and the time over which the force is sustained (Brand, 1983). The most important aspect of rehabilitation in neuropathic amputee patients and especially in patients with umlateral amputation is prevention of a secondary amputation, particularly in non-amputee limb.

We hypothesized that most of chronic leprotic patients with umlateral amutation have higher grades of neuropathy and abnormal foot plantar pressure. Therefore, these patients are exposed to higher risk of secondary amputation in their non-amputee limb. Considering above, we have designed present study to investigate clinical, electrodiagnostic and pedobarographic findings in non-amputee limb of chronic leprotic patients with umlateral trans-tibial amputation to determine neuropathy and plantar foot pressure in non-amputee limb.

MATERIALS AND METHODS

The present prospective cross-sectional study was carried out in the main lepromatous disease centre in Eastern Azerbaijan, Tabriz Bababaghi and Imam Reza Hospitals at summer of 2008. This centre is located near to Tabriz and provided medical and rehabilitative cares for leprotic patients, particularly chronic and disabled ones.

Documents of patients were reviewed to find patients with unilateral trans-tibial amputation. Ten chronically disabled patients with trans-tibial amputation were recognized. All of these patients used the fitted prosthesis. These patients were invited and allowed to participate in this study after signing informed consent. The ethic committee at Tabriz University of Medical Sciences (TUMS) reviewed and approved the study protocol which is in compliance with the Helsinki Declaration.

Initially, an interview was performed. Demographic characteristics of patients were recorded. Afterwards, physical examinations and electrodiagnostic studies were performed using Medelec Synergy devise (VIASYS health care, UK). Sensory nerve conduction (SNAP) study of median, ulnar and sural nerves and Compound Motor Action Potentials (CMAP) study of median, ulnar, deep proneal and tibial nerves were performed using standard method (Husain and Malaviya, 2007) to determine presence and type of neuropathy. Importantly, temperature was kept at standard level in both lower and upper limbs. Considering the role of hands in using of prostethsis and presence of unilateral trans-tibial amputation (to determine type of neuropathy; mononeyropathy or polyneuropathy), hands' electrodiagnostic study was performed in present study population.

To complete the examination, pedobarographic assessment was done by Mini-Emd pedobarography device (Novel, Munich, Germany). This system measures static and dynamic plantar pressure. In static measurements, patient was asked questions to prevent focusing of patient on the plantar side of the foot. They were also asked to look at a fixed point on the opposite wall which was located in three meters away. The data on monitor screen were fixed and recorded when the weight on the intact foot was observed to equal 50% of the body weight. The following five parameters were evaluated during static measurement of intact foot: 1- Forefoot peak measure (P), 2- Rarefoot peak pressure, 3- plantar total contact area (cm^2), 4- Forefoot peak area (N), 5- Rarefoot peak force (N). The printout of a sample static measurement is shown in Fig. 1. For dynamic measurement, patient was asked to walk continuously. They were guided to put the non-amputee foot on the platform during normal walking rhythm. This rhythm was considered characteristic for each patient. The aforementioned parameters were also measured in dynamic state.

To compare the pedobarographic findings of leprotic patients with normal values, pedobarographyic data of 10 age, sex, weight and height-matched healthy subjects was extracted and used from our center data bank. healthy subjects have an American Orthopedic Foot and Ankle Society score (Kitaoka *et al*., 1994) of 100 which was indicated a normal feet.

Data were analyzed by SPSS software package for windows version 13 (SPSS Inc, Chicago, Ill, USA). The results are presented as Mean±SD. The static and dynamic pedobarographic parameters of leprotic patients were compared with our center normal values using independent sample t-test. A p-value less than 0.05 considered significant.

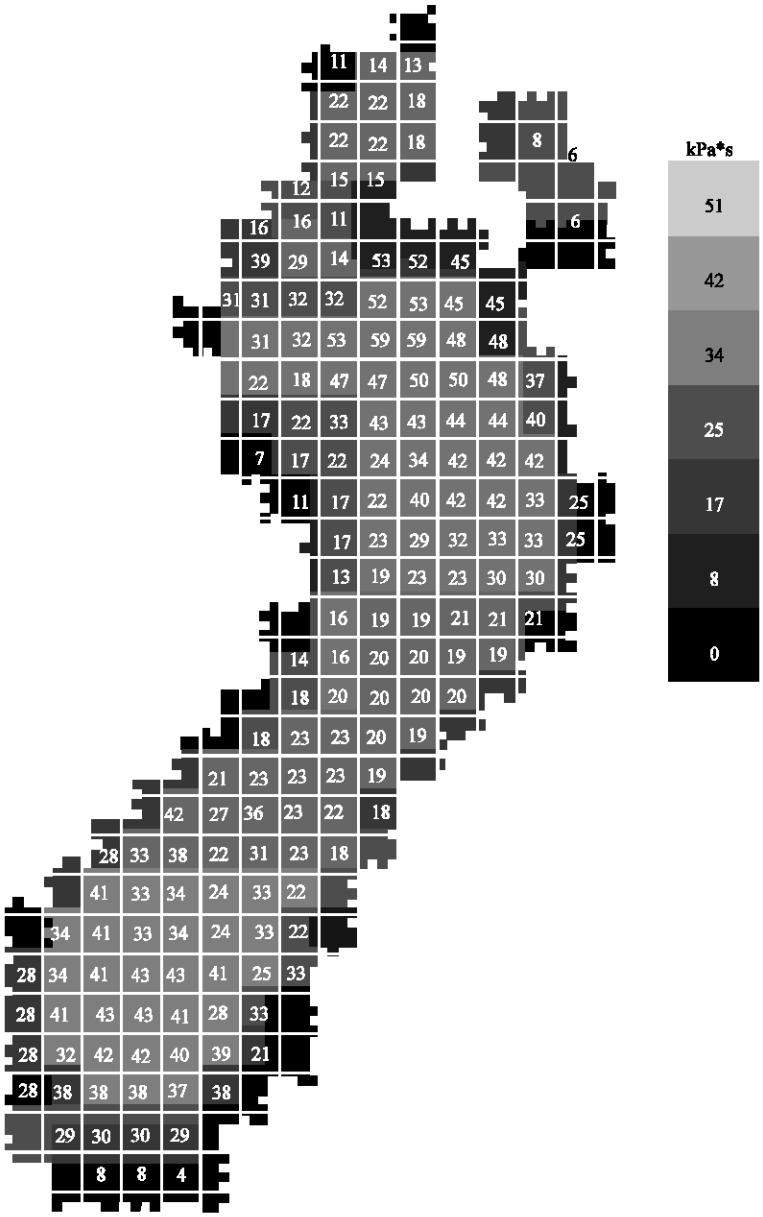

Fig. 1: Averaged pressure-time integral picture. The printout of a sample static measurement. This pedobarographic printout revealed an abnormal plantar pressure in forefoot of chronic leprotic patient with unilateral tans-tibial amputation

RESULTS

This study was performed on ten leprotic patients with unilateral trans-tibial amputation. The demographic and clinical characteristics of studied participants are demonstrated in Table 1.

All subjects used exoskeletal patellar tendon-bearing prosthesis with soft socket, Solid Ankle Cusionoid Heal (SACH) foot and cuff suspension.

According to chronic history of disease, all of subjects had received multidrug therapy with dapsone, rifampin and clofazimine and completed their therapeutic course.

Out of 10 subjects, seven had right side trans-tibial amputation and remained three subjects had left side amputation.

Eight subjects had hand deformities. Four subjects had claw hand which was bilateral in two patients and

Table 1: The demographic and clinical characteristics of the study participants

Characteristics	Leprotic patients	Healthy subjects
	(Mean±SD)	
Age	66.57±8.45	63.72±7.64
Male/Female ratio	8/2	8/2
Weight (kg)	72.30±4.34	75.18±7.66
Height (cm)	172.20±5.51	178.49±7.15
Disease duration (years)	37.81±8.47	-
Leprosy type	1 tuberclosis	
	1 borderline	-
	8 lepromatose	
Duration of amputation (years)	20.80±11.92	-
Hand deformity (percent)	80%	-

SD: Standard deviation

Table 2: Comparison of static and dynamic pedobarographic values between the leprosy patients and our laboratory normal data

Pedobarographic parameters	Leprotic patients	Healthy subjects	p-value
	(Mean±SD)		
Static total plantar area (cm^2)	80.79±18.63	88.41±16.80	0.047
Dynamic total plantar area (cm^2)	78.60±14.32	120.11±14.69	0.004
Static forefoot peak pressure (kPa)	382.83±73.10	302.00±56.56	0.011
Dynamic forefoot peak pressure (kPa)	810.65±18.35	723.53±43.31	0.031
Static rarefoot peak pressure (kPa)	268.12±65.72	320.45±36.34	0.029
Dynamic rarefoot peak pressure (kPa)	257.89±83.44	600.86±46.17	<0.001

SD: Standard deviation

affected left side in remained subjects. Finger amputation was occurred in five subjects; Amputations was affected both of hands, left or right hand respectively in two, one and two subjects. Claw hand was accompanied with finger amputation in two subjects.

In electrodiagnostic evaluation, reliable response was not detected from tested sensory and motor nerves, except the very low amplitude finding for deep preoneal nerve in one subject. These findings showed severe peripheral sensorimotor polyneuropathy in all subjects.

As shown in Table 2, static total plantar area, dynamic total plantar area, static rarefoot peak pressure and dynamic rarefoot peak pressure were lower in leprotic patients, while static forefoot peak pressure and dynamic forefoot peak pressure were higher in these patients.

DISCUSSION

Results revealed severe generalized sensorimotor polyneuropathy and abnormal foot plantar pressure in non-amputee limb of chronic leprotic patients with unilateral trans-tibial amputation. This condition exposed such leprotic patients to higher risk of secondary amutation.

Although, Iran is not among the high endemic countries of leprosy, Eastern Azerbaijan, a northwest province of Iran, is considered to be one of the endemic areas for this disease (Golforushan *et al*., 2006). During present prospective study, 10 chronic leprotic patients with unilateral trans-tibial amputation were evaluated. Eighty percent of patients were male which is consistent with epidemiologic studies (Lockwood, 2004; World Health Organization, 1996, 2006). In general, leprosy had been more prevalent in male than females in different studies (Fine, 1982). In physical examination, 80% of patients had different deformities in their hands including claw hand and auto amputation of fingers. Hand deformities can significantly affect patient's function in using of prosthesis, cane or crutch and may interfere with proper foot care. Considering prosthesis, all patients used exoskeletal, SACH foot trans-tibial prosthesis with anatomic suspension. Hand function is very important in donning and doffing of such prosthesis.

In electrodiagnostic evaluation, all of studied patients had severe peripheral generalized sensorimotor polyneuropathy. The role of electrodiagnostic evaluation of nerve function in diagnosis and assessment of different neuropathies is well established (Bryceson and Pfoltzgraft, 1990; Husain and Malaviya, 2007; Van Veen *et al*., 2009). The main target of Mycobacterium Leparae is the peripheral nerve (Minauchi, 1987; Ganapati *et al*., 2003). In fact, the main etiology of morbidity in leprotic patients is peripheral neuropathy which is responsible for deformities and disabilities in many leprotic patients (Bryceson and Pfoltzgraft, 1990). Peripheral nerve involvement in leprosy may vary from involvement of an interadermal nerves in the cutaneous patches to a major lesions in the peripheral nerve trunk (Husain and Malaviya, 2007). Considering longstanding leprosy in studied leprotic patients (near to 21 years), abnormal findings were shown in all of major nerves which may lead to more disabilities and functional limitations. Generally, leprotic patients developed mononeuropathy multiplex and generalized sensorimotor

polyneuropathy which last one developed in all studied population considering longstanding disease. As all of studied samples had unilateral foot amputation, hand electrodianostic study was performed to diagnosis type of neuropathy. The insensitive foot following neuropathy is the most common chronic residual deformity of leprosy. This condition, any damage to skin barrage becomes a potential port of entry for infectious agents and leads to deep infection and ultimately amputation of organ which was called secondary amputation in leprotic patients. In patient who lost one of feet, saving opposite foot has critical role in patient's future life quality, especially when the patient have neuropathy. The most important aspect of rehabilitation in neuropathic leprotic patient is prevention of secondary amputation.

The third and innovative part of present investigation was pedobarographic evaluation. Measurement of static and dynamic foot pressures in healthy and neuropathic patients were reported in the literature (Rosenbaum *et al*., 1994; Hughes, 1993; Lord *et al*., 1986; Chen *et al*., 1995; Franks *et al*., 1983; Betts *et al*., 1980). A few studies have been published about pedobarographic examination of leprotic patients and pressure distribution patterns under the foot soles of leprotic patients (Lim and James, 2008; Bhatia and Patil, 1999). To the best of our knowledge, present study is the first report of pedobarographic examination in leprotic patients with unilateral trans-tibial amputation. Results of present study revealed a significant abnormality in peak forefoot pressure and total contact area in leprotic patients, in comparison to normal data. The higher forefoot peak pressure in leprotic patients could expose the foot to higher risk of ulceration. Total contact area in static and dynamic evaluation was another important issue in leprotic patients. Despite normal increment at total plantar area in dynamic pedobarography, we have not found any similar increment in our patients. This finding suggests profound biomechanical impairment of foot and gait abnormality in leprotic patients. Such abnormality especially in gait may arise from unilateral trans-tibial amputation and use of prosthesis in leprotic patients of present study.

The prevalence of disabilities in leprotic patient in different studies had been 30-82% and foot problems are of major concern (Reddy and Bansal, 1984; Zhang *et al*., 1993; Smith *et al*., 1980; Kalla *et al*., 2000). In fact, the most important aspect of rehabilitation care in amputee patients especially in leprotic patients is prevention of a second amputation.

Based on clinical, electrodiagnostic and pedobarographic findings, actually all of studied leprotic patients suffered from profound generalized sensorimotor polyneuropathy and high plantar pressure under the forefoot which may expose these patients to higher risk of secondary amputation. Also, this study revealed severe generalized polyneuropathy of hand which may affect patient functions in using prosthesis and taking care of foot.

Finally in recommendations, comprehensive rehabilitation programs with preventive foot care and use of proper orthopedic shoes should be considered in leprotic patients. Because of presence of unilateral trans-tibial amputation and severe sensorimotor polyneuropathy, all patients with such condition are exposed to high risk of ulceration in intact foot. Therefore, patients with similar condition need custom-molded, in-depth shoe with total contact plastazote insoles and other additional modifications such as rooker sole and long steel shank to decrease forefoot pressure during gait.

Patient's education is another important rehabilitation strategy and these patients should be trained about footwear, foot self inspection and skin care.

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