ABSTRACT
Objective: to report the results of neurotrophic ulcers healing. Method: case-type descriptive study conducted with six leprosy patients aged between 20 and 50 years, with ulcers treated using low-power laser. Patients underwent two sessions of laser therapy per week, totaling 12 applications of light beams on the neurotrophic ulcers. The Pressure Ulcer Scale for Healing was used to assess the healing effect of low-power laser. The research project was approved by the Research Ethics Committee, under Protocol No. 0001/2011. Results: significant improvement in the healing process was observed after treatment. Conclusion: the preliminary results showed that the use of low-power laser, applied on neurotrophic ulcers, promoted celerity in the healing process. Descriptors: Leprosy; Cutaneous Ulcer; Low-Power Laser Therapy; Healing.

RESUMO
Objetivo: relatar os resultados de cicatrização de úlceras neurotróficas. Método: estudo descritivo, tipo estudo de caso, realizado com seis pacientes com hanseníase entre 20 e 50 anos de idade, com úlceras tratadas com laser de baixa potência, submetidos a duas sessões de terapêutica por semana, totalizando 12 aplicações do feixe de luz sobre a úlcera neurotrófica. Para a avaliação do efeito cicatrizante do laser de baixa potência, foi utilizada a escala Pressure Ulcer Scale for Healing. O projeto de pesquisa foi aprovado pelo Comitê de Ética em Pesquisa, sob Protocolo n. 0001/2011. Resultados: após o tratamento, observou-se melhora expressiva no processo de cicatrização. Conclusão: os resultados preliminares demonstraram que o uso do laser de baixa potência, aplicado sobre as úlceras neurotróficas, promoveu a celeridade no processo de cicatrização. Descritores: Hanseníase; Úlcera cutânea; Terapia a Laser de Baixa Potência; Cicatrização.

RESUMEN
Objetivo: reportar los resultados de la cicatrización de úlceras neurotróficas. Método: estudio descriptivo, tipo estudio de caso, realizado con seis pacientes con lepra comprendidos entre 20 y 50 años de edad, con úlceras tratadas con láser de baja potencia. Los pacientes fueron sometidos a dos sesiones de terapéutica láser por semana, con un total de 12 aplicaciones del haz de luz sobre las úlceras neurotróficas. Para la evaluación del efecto cicatrizante del láser de baja potencia fue utilizada la escala Pressure Ulcer Scale for Healing. El proyecto de investigación fue aprobado por el Comité de Ética de la Investigación, con el Protocolo N° 0001/2011. Resultados: fue observada una mejoría significativa en el proceso de cicatrización después del tratamiento. Conclusion: los resultados preliminares demostraron que el uso de láser de baja potencia, aplicado sobre úlceras neurotróficas, promovió rapidez en el proceso de cicatrización. Descriptores: Lepra; Úlcera cutánea; Terapia Con Láser de Baja Potencia; Cicatrización.

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INTRODUCTION

Leprosy is an infectious and contagious disease requiring mandatory report in Brazil. It is caused by the alcohol-resistant acid bacillus Mycobacterium leprae, which exhibits tropism through the mixed peripheral nerves, in addition to affecting the skin and the oral and nasal mucous membranes.

According to the Ministry of Health, man is considered the only source of leprosy transmission. Infection takes place through contact of susceptible individuals with untreated bacilliferous patients through the upper airways. Among other factors, the occurrence of different clinical manifestations is due to the host/parasite interaction after two to seven years of incubation.

This disease has high infectivity, low pathogenicity and high disabling potential. Nerves affection can lead to neural damage and changes of sensory and/or motor functions. This way, it predisposes to the appearance of neurotrophic ulcers, which can evolve to osteomyelitis, gangrene, amputations and loss of bone segments. Neural impairment generates different degrees of disability, changes in the levels of pain and decreased muscle strength. Early physiotherapeutic intervention is indicated in order to minimize these functional changes.

Leprosy also impairs the quality of life related to health and interpersonal relationships, causing suffering, in addition to pain and malaise strictly linked to physical harm and stigmatizing power. Quality of life impairment is more intensely associated to some specific situations of diseases in the multibacillary clinical form, such as leprosy reaction and physical disability.

Neurotrophic ulcers—a frequent complication in patients with leprosy—occur due to loss of protective sensibility or anesthesia. This results in changes of the motor fibers due to weakness and paralysis of the muscles and leads to deformities, impairment of the function and increased risk of the emergence of this kind of wounds.

There are several products and dressings targeted to the treatment of cutaneous ulcers. A therapeutic modality currently used is the low-power laser therapy associated with different dressings to assist in the healing process. The use of laser therapy aims to speed up the healing process as a result of the photochemical, photophysical, and photobiological effects on cells and tissues.

Although low-power laser has beneficial effects on healing processes, its use for the treatment of ulcers, particularly neurotrophic ulcers, is not frequent in our context. Thus, it constitutes a resource that deserves the attention of researchers and health professionals involved in healthcare provided to patients with wounds, in order to broaden the range of options that can contribute to the healing process and consequently to the quality of life of these patients. In view of the above, this study aims to report the results of neurotrophic ulcers healing.

METHOD

This is a clinical case study conducted with six patients in the outpatient sector of a reference hospital for treating neurotrophic ulcers in the city of João Pessoa, State of Paraíba. The service has a Skin Department with a trained and qualified multiprofessional team (nurses, nursing technicians, dermatologists, vascular surgeon, plastic surgeon, physical therapist, nutritionist, psychologist, and social service). This service aims at the rapid rehabilitation, better quality of life and return to the family and social life of patients with neurotrophic ulcers.

The patients (one woman and five men, aged between 20 and 50 years) had been diagnosed with leprosy and neurotrophic ulcers without associated chronic diseases. They were non-smokers and did not consume alcoholic drinks and had already been cared for in the outpatient Skin Department of the hospital. Patients excluded from the study were those who had failed to attend three consecutive sessions during treatment, presented carcinomas, bleeding, or gravid uterus.

The research met the standards for conducting research with humans according to the Declaration of Helsinki, and it was approved by the Research Ethics Committee of the State Department of Health of Paraíba, under Opinion No. 0001/2011. All patients who agreed to participate in the study signed an informed consent form.

The Pressure Ulcer Scale for Healing (PUSH) was developed in 1996 by the National Pressure Ulcer Advisory Panel (NPUAP). It was adapted and validated in Brazil and used for assessing the ulcers in the present study. This scale was used for observation of the area of the wound, with score from 0 to 10 regarding the length and width of the ulcer and 0 to 3 for the amount of exudate.

For the type of tissue, the PUSH score ranges from 0 to 4 (0 - closed wound; 1 - epithelial tissue; 2 - granulation tissue; 3 - sphenecul; and 4 - necrotic tissue). For the amount of wound drainage, the distribution is:
Oliveira JM, Torquato SG, Mello D et al.

The method for laser application consisted of scanning the ulcer bed (15 minutes) and irradiating per points on the ulcer edges (15 seconds per point), at a distance of 1 to 2 cm² between points. The laser pen was covered by a PVC plastic and the researcher wore procedure gloves. After each service, the asepsis of the equipment was performed using 70% alcohol.

When the physiotherapist completed the laser application, the nurse selected the dressing to be used on the wound after assessing its characteristics. Four types of bandages were used for the dressings: (a) sterile absorbent polyurethane foam, impregnated with silver ions and with an outer layer impermeable to water, organic fluids and bacteria; (b) tape with calcium alginate, fibrous and flexible tissue, highly absorbent (indicated for filling cavities with variable exudation); (c) composed of unsaturated fatty acids (linoleic acid), medium-chain triglycerides (caprylic acid, capric acid, linoleic acid), vitamin E, and vitamin A, with exemption of components of animal origin; and (d) hydrolytic gel for debridement composed of calcium alginate, collagen and aloe vera gel.

RESULTS

Table 1 shows the progression of the wound area from the first to the sixth week of laser applications and dressings used.

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
<th>Subject 5</th>
<th>Subject 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st</td>
<td>36</td>
<td>9</td>
<td>8.75</td>
<td>27.5</td>
<td>7.5</td>
<td>4</td>
</tr>
<tr>
<td>2nd</td>
<td>27</td>
<td>5.28</td>
<td>4</td>
<td>18</td>
<td>3.75</td>
<td>1.5</td>
</tr>
<tr>
<td>3rd</td>
<td>27</td>
<td>3</td>
<td>0</td>
<td>14</td>
<td>1</td>
<td>0.8</td>
</tr>
<tr>
<td>4th</td>
<td>20</td>
<td>1.5</td>
<td>-</td>
<td>10.8</td>
<td>0.4</td>
<td>0.25</td>
</tr>
<tr>
<td>5th</td>
<td>20</td>
<td>0.8</td>
<td>-</td>
<td>7.2</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6th</td>
<td>16.2</td>
<td>0.15</td>
<td>-</td>
<td>2.4</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>

Legend: 0 = absent; 1 = small amount; 2 = moderate; 3 = large amount.

According to Table 2, it is initially observed that all subjects presented from moderate (saturated ulcer tissue, drainage may or may not be well distributed in the wound) to large exudate amounts (ulcer tissue bathed in fluid, located on the sole of the foot). During the consultations with the professionals, the patient stated that always avoided putting high and prolonged pressure on the limb, this way preventing local ischemia, which would hinder the healing process.

Table 2. Exudate amount according to the PUSH. João Pessoa, 2012.

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
<th>Subject 5</th>
<th>Subject 6</th>
</tr>
</thead>
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<td>2</td>
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<tr>
<td>3rd</td>
<td>3</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4th</td>
<td>2</td>
<td>2</td>
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<td>1</td>
<td>1</td>
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<td>0</td>
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<tr>
<td>6th</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

According to Table 2, it is initially observed that all subjects presented from moderate (saturated ulcer tissue, drainage may or may not be well distributed in the wound) to large exudate amounts (ulcer tissue bathed in fluid, located on the sole of the foot). During the course of treatment, it was found that the decrease of the exudate occurred from the second week in subjects 2, 3 and 5. On the other hand, subject 1 presented...
Exudate reduction in the fourth week and the subject 6 in the third week, whose drainage at the end of the sixth week still remained moderate.

Table 3 shows the type of tissue present in the ulcer beds during the therapeutic applications

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
<th>Subject 5</th>
<th>Subject 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Week</td>
<td>3</td>
<td>3</td>
<td>2</td>
<td>3</td>
<td>3</td>
<td>2</td>
</tr>
<tr>
<td>2nd Week</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>3rd Week</td>
<td>2</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>4th Week</td>
<td>2</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
<tr>
<td>5th Week</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6th Week</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

Legend: 0 = Closed wound; 1 = Epithelial tissue; 2 = Granulation tissue; 3 = Sphacelus; 4 = Necrotic tissue.

It can be observed that in just two weeks of laser application all six subjects presented evolution in the ulcer healing process. In the third week, subject 3 presented healing by wound closure, and subject 5 and 6 showed complete healing in the fifth week. Since the wounds of subjects 1, 2 and 4 had larger diameters, they did not reach the total closure of the ulcers in the six-week treatment, but they showed great evolution in tissue repair throughout the course of treatment.

Table 4 shows the sum of the scores assessed with the PUSH.

<table>
<thead>
<tr>
<th>Week</th>
<th>Subject 1</th>
<th>Subject 2</th>
<th>Subject 3</th>
<th>Subject 4</th>
<th>Subject 5</th>
<th>Subject 6</th>
</tr>
</thead>
<tbody>
<tr>
<td>1st Week</td>
<td>16</td>
<td>14</td>
<td>12</td>
<td>16</td>
<td>7</td>
<td>10</td>
</tr>
<tr>
<td>2nd Week</td>
<td>15</td>
<td>11</td>
<td>8</td>
<td>14</td>
<td>6</td>
<td>8</td>
</tr>
<tr>
<td>3rd Week</td>
<td>15</td>
<td>9</td>
<td>0</td>
<td>13</td>
<td>3</td>
<td>5</td>
</tr>
<tr>
<td>4th Week</td>
<td>13</td>
<td>8</td>
<td>11</td>
<td>2</td>
<td>3</td>
<td>3</td>
</tr>
<tr>
<td>5th Week</td>
<td>13</td>
<td>5</td>
<td>10</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>6th Week</td>
<td>13</td>
<td>3</td>
<td>7</td>
<td>1</td>
<td>1</td>
<td>1</td>
</tr>
</tbody>
</table>

Legend: Higher values mean non-healed stages of the ulcer; zero means that the ulcer was healed.

According to Table 4, it can be observed that during treatment, considering the sum of the PUSH scores, all patients presented evolution in the healing process, noting that three of the subjects had complete healing of the wound in up to five weeks of treatment. Only three subjects did not complete healing during treatment in the six weeks, although they showed gradual and considerable evolution.

DISCUSSION

The results show complete tissue repair of three ulcers treated with dressings—selected according to the characteristics of the wounds—associated with the low-power laser. Subject 6 presented a superficial ulcer in the left upper limb (lateral surface of the arm), what facilitated healing due to its location. Subject 5 presented an ulcer in the right lower limb. The wound was also superficial, located in the posterior part of the lateral border of the foot.

The depth of the wound constitutes one aspect of extreme relevance for healing, since the deeper the injury, the greater the time required for restoration of the affected layers. At the same time, the depth increases the risk of complications such as infection. Therefore, the fact that the ulcers were superficial in the three patients assessed was a contributory factor in healing.

The success in the process of complete wound healing can also be caused by the laser action due to the absorption of the radiation by the body. The light energy is absorbed in the cytochromes and porphyrins, within the mitochondria and cell membrane, producing a small amount of free oxygen as a result of absorption inside the cell, forming a gradient of protons across the cell membrane and the membrane of the mitochondrion. This change in the permeability of the cell membrane also causes changes in the permeability of the mitochondrial membrane, leading to an increase in the level of cellular adenosine triphosphate (ATP). The penetration of radiation and the amount absorbed will depend on the absorbent structures of the tissue or skin radiated and body characteristics.21

The subjects who had larger wounds (identified as 1 and 4), as expected, did not achieve complete wound healing until the sixth week of treatment. However, it can be observed that there was a significant decrease in the areas of the wounds, which began to occur from the second week and, at the end of follow-up, healing greater than 50% was achieved in the affected area of subject 1 and greater than 90% in subject 4 (Table 1).
The effect on exudate reduction can be caused by the laser associated with the other dressings. The effect of the laser on the inflammation initially occurs due to the inhibition of chemotactic factors released. It interferes on the effects of chemical mediators induced in the inflammation by changing vascular permeability with consequent decrease in the exudate amount.21,23

A study showed the effects of laser on healing and decreasing exudate, especially in chronic ulcers, proving to be more efficient than conventional methods used today.24 Another study obtained 100% of healing in arterial, venous and diabetic ulcers using clinical treatment associated with HeNe laser (632.8 nm) and AsGa laser (904 nm). In the present study, some cases evolved to complete wound healing in a short treatment time and deeper wounds had not only reduced exudate but also reduced sizes; even though there were few sessions of 670 nm laser application.

A recent research showed four wavelengths whose stimulation at the cellular level was maximal. They were 620, 670, 760, and 830 nm, providing a much greater stimulation of the DNA/RNA synthesis. This way, they favor epithelial regeneration, collagenogenesis, neovascularization, and increase in tension force.26

The low-power laser stimulates cell membranes and mitochondrias, inducing cellular biomodulation. It is indicated for pathological pictures in order to accelerate the process of tissue repair and decrease acute or chronic edematous and algic pictures. Laser beams have primary and secondary effects when they are absorbed by the tissues.25 The primary effects are biochemical, bioelectrical and bioenergetic. Biochemical effects consist of releasing preformed substances such as histamine, serotonin and bradykinin, which will stimulate the production of ATP and the inhibition of prostaglandins production. The bioelectrical effect comprises the improvement of the sodium-potassium pump function, responsible for the maintenance of the cell membrane potential and the increase of ATP production. Finally, the bioenergetic effect is the energetic normalization of the bioplasma.

The side-effects consist primarily in local circulation through the biochemical effect of histamine release and increased cell tropism, due to the bioelectric effect of increased ATP production, mitotic speed and tissue repair. As a result of all the effects produced, the low-power laser eventually has a supporting role in the healing process.

Healing includes integrated action of cells, matrix, and chemical messenger in order to restore the integrity of the tissue as soon as possible. The repair is not a simple linear process in which growth factors trigger cellular proliferation, but the integration of dynamic processes that include soluble mediators, figurative elements of the blood, extracellular matrix production, and parenchymatous cells. Proper vascularization and the importance of perfusion and oxygenation are indispensable factors for healing to occur.

The application of low-power laser has been positive in the inflammatory stage and tissue repair stages. Cellular photobiomodulation occurs, i.e., growth factors and reduction of the number of inflammatory cells take place at the same time. Thus begins the second stage called proliferative, in which the neoinformation of blood vessels occurs due to photostimulation of endothelial cells, proliferation of fibroblasts and consequent deposition of collagen. Thereby, the formation of granulation tissue for effective wound contraction is stimulated.21 The remodeling of the wound is the last stage of the healing process. This is constituted by the reorganization of the blood vessels and collagen fibers. In addition to increase the proliferation of fibroblasts in the wound bed, low-power laser therapy also causes a significant angiogenesis increase.27

A schema for dose criteria employed in low-power laser application depends on the clinical situation.19 The uses are: doses of 2 to 4 joules for analgesic effect; doses of 1 to 3 joules for anti-inflammatory and circulatory effect; and doses of 3 to 6 joules for healing effect. The same author also describes the type of dosage according to the stage of the ulcer. Low doses of 1 to 3 joules are used for acute ulcers, medium doses of 3 to 4 joules for subacute ulcers, and high doses of 5 to 7 joules for chronic ulcers. A dose of 5 joules was used in the clinical cases assessed in the present study, obtaining a satisfactory result in the healing process. This fact demonstrates the suitability of the dose for the characteristics of the ulcers.

Disabling factors can be observed in individuals afflicted by leprosy, which is an infectious and contagious chronic disease that mainly affects the peripheral nerves responsible for the motor and sensory stimulus conduction that enables the function of upper and lower limbs. These disabilities can lead to...
The results obtained corroborate the viability of using low-power laser as adjuvant in the healing process. It enables faster healing of neurotrophic ulcers when associated with other dressing types. Although studies available to the scientific community have demonstrated that the low-power laser is a viable resource, pointing to the rapid improvement in the treatment of neurotrophic ulcers, these studies are still scarce. Therefore, further research with methodological strictness and control of different variables, such as case control that assess the effect of low-power laser on neurotrophic ulcers healing, need to be conducted, in order to reinforce/confirm the beneficial effects of this technology for this type of ulcers and other types.

REFERENCES


http://www.scielo.br/pdf/abd/v82n5/a06v82n05.pdf


Available from:  
http://www.revistas.usp.br/fpusp/article/download/12232/14009


Available from:  


16. Corazza AV. Fotobiomodulação comparativa entre LASER e LED de baixa intensidade na angiogênese de feridas cutâneas de ratos [dissertação]. Universidade de São Paulo/USP; 2005.


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