

## Efficacy of deep tissue laser therapy in pressure ulcer healing in patient with quadriplegia: Case Report

### Eficácia da terapia a laser de tecidos profundos na cicatrização de úlceras por pressão em paciente com tetraplegia: relato de caso

Manu Goyal<sup>1</sup>   
Saumya Kothiyal<sup>2</sup> 

<sup>1</sup>Department of Musculoskeletal Physiotherapy, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana -133207. Haryana, India. manu.goyal@mmumullana.org

<sup>2</sup>Corresponding author. Department of Musculoskeletal Physiotherapy, Maharishi Markandeshwar Institute of Physiotherapy and Rehabilitation, Maharishi Markandeshwar (Deemed to be University), Mullana -133207. Haryana, India. saumyakothiyal28@gmail.com

**ABSTRACT | CONTEXT:** Pressure ulcers (PU) are the most common complication noted in bed-ridden patients. The purpose of this case report is to explore the efficacy of class IV near-infrared laser therapy in the treatment of large and severe pressure ulcers. **FINDINGS:** A 53-years-old male diagnosed with quadriplegia due to cervical spine tuberculosis at level C5-C6 was admitted to a hospital with an unstageable pressure ulcer over the sacrum and National Pressure Ulcer Advisory Panel Pressure stage 3 ulcers over the right trochanteric area for pressure injury. No associated comorbidities like diabetes mellitus and hypertension were present. The Lite Cure Gallium-Aluminum-Arsenide (GaAlAs) class IV near-infrared laser, non-contact, continuous beam emission (non-pulsing) at 980nm wavelength, was used. The dosage parameters used were: 7.5 - 10 watts power; dose range 7 J/cm<sup>2</sup> - 9 J/cm<sup>2</sup>; sacral area (13×9) cm<sup>2</sup> and trochanteric area (10×8) cm<sup>2</sup>; at varying energy densities; treatment time ranges between 8 to 15 minutes for each ulcer. Total 19 sessions over 6 weeks were given to treat pressure ulcers. Dimensions (area) and severity stage of pressure ulcer were noted pre-intervention and after the intervention. The post-treatment data revealed the clinical improvement in both outcomes. **CONCLUSION/ CLINICAL SIGNIFICANCE:** This case report demonstrates the anti-inflammatory, analgesic, and bio-stimulative healing effects of Class IV laser therapy treatment showing a reduction in the dimensions and severity of pressure ulcers.

**KEYWORDS:** Anti-inflammatory agents. Lasers. Pressure Ulcers. Quadriplegia. Sacrum.

**RESUMO | CONTEXTO:** Úlceras por pressão (UP) são a complicação mais comum observada em pacientes acamados. O objetivo deste relato de caso é explorar a eficácia da terapia a laser no infravermelho próximo de classe IV no tratamento de úlceras de pressão grandes e graves. **DADOS:** Um homem de 53 anos com diagnóstico de tetraplegia devido à tuberculose da coluna cervical no nível C5-C6 foi admitido em um hospital com úlcera por pressão instável sobre o sacro e úlceras de pressão do *National Pressure Ulcer Advisory Panel* estágio 3 sobre a área trocântérica direita para lesão por pressão. Não havia comorbidades associadas, como diabetes mellitus e hipertensão. Utilizou-se o *Lite Cure Gallium-Aluminium-Arsenide* (GaAlAs) classe IV laser próximo ao infravermelho, sem contato, emissão de feixe contínuo (não pulsante) no comprimento de onda de 980 nm. Os parâmetros de dosagem usados foram: 7,5 - 10 watts de potência; faixa de dosagem 7 J / cm<sup>2</sup> - 9 J / cm<sup>2</sup>; área sacral (13 × 9) cm<sup>2</sup> e área trocântérica (10 × 8) cm<sup>2</sup>; em diferentes densidades de energia; o tempo de tratamento varia entre 8 a 15 minutos para cada úlcera. No total, 19 sessões durante um período de 6 semanas foram administradas para tratar úlceras de pressão. Dimensões (área) e estágio de gravidade da úlcera por pressão foram anotados antes da intervenção e após a conclusão da intervenção. Os dados pós-tratamento revelaram melhora clínica em ambos os desfechos. **CONCLUSÃO / SIGNIFICADO CLÍNICO:** Este relato de caso demonstra um efeito anti-inflamatório, analgésico e bioestimulante de cicatrização do tratamento com laserterapia Classe IV, apresentando redução nas dimensões e gravidade das úlceras por pressão.

**PALAVRAS-CHAVE:** Agentes anti-inflamatórios. Lasers. Úlceras de pressão. Tetraplegia. Sacro.

## Introduction

Pressure ulcers (PU) are the most common complication noted in bedridden patients due to neurological problems and prolonged periods of immobilization, leading to physical and psychological impairments. PU refers to a localized injury or breakdown in skin and underlying soft tissue due to constant high pressure on the skin surface, leading to ischemia and necrosis of the tissue.<sup>1</sup> It commonly affects the areas around the bony prominences<sup>2</sup>, mainly over the sacrum, greater trochanter region, heels, and hip regions, respectively, as supine and side-lying are commonly acquired positions by the patients in hospital settings. It poses a life-threatening risk to the patients, deteriorates the quality of life, and increases the economic and emotional burden on the family members by increasing the hospital stay.<sup>3</sup>

Many conservative treatments in the form of nutritional supplements, medicinal dressing, wound debridement, hyperbaric oxygen therapy, and photo-bio-modulation, i.e., low-level laser therapy (LLLT), are used in PU management. Previous studies have proved the efficacy of LLLT in superficial wound healing.<sup>4,5</sup> However, the class IV high-intensity near-infrared laser therapy has proved to have deeper penetration than LLLT, thereby producing a biostimulative effect on deeper tissues, enhancing the blood flow, and accelerate the mechanisms of wound healing.<sup>6,7</sup> To the author's knowledge, there is no literature available that shows the effect of class IV high-intensity near-infrared laser therapy on PU in any patient. Therefore, the purpose of this report is to explore its effect in quadriplegia patients having PU at two sites, i.e., Sacrum and Right Greater trochanter.

## Case report

### History

53-years-old male suffering from quadriplegia for one year due to cervical spine tuberculosis at C5-C6 level was admitted with the chief complaint of large non-healing bed sores over the lower back and right hip region, respectively.

### Assessment

The clinical examination revealed an unstageable PU (obscured with eschar and or slough) over the sacrum (S), measuring 13×9 cm (Fig 1A) and stage 3 PU over the right greater trochanteric (RGT), measuring 10×8 cm (Fig 2A) according to National Pressure Ulcer Advisory Panel Pressure (NPUAP) staging system.<sup>1</sup> The physical examination of the patient's ulcer was done without any diagnostic challenge. The 2D non-contact simple ruler method technique was used to measure the dimensions of the PU.<sup>8</sup> The prognosis according to the staging of ulcer grading was explained to the patient and his family members.

### Intervention

The study was carried out in the Neuro Physiotherapy Outpatient department of a tertiary hospital. The Lite Cure Gallium-Aluminum-Arsenide (GaAlAs) class IV near-infrared laser, non-contact, continuous beam emission (non-pulsing) at 980nm wavelength, was used. The dosage parameters used were: 7.5 -10 watts power; dose range 7 J/cm<sup>2</sup> - 9 J/cm<sup>2</sup>; sacral area (13×9) cm<sup>2</sup> (Fig 1A) and trochanteric area (10×8) cm<sup>2</sup> (Fig 2A); at varying energy densities; treatment time ranges between 8-15 minutes for each ulcer. The wound area was distributed using the grid method, and the application was performed using the scanning motion technique with the help of a non-contact probe with a velocity of 1 cm/s. Total 19 sessions over 6 weeks were given to treat pressure ulcers at both sites (Table 1). The dosage of the therapeutic intervention was changed according to the reassessment of the pressure ulcer. The patient was advised to continue the drugs related to tuberculosis and dietary instructions as usual.

**Table 1.** Summary of 19 Treatment Sessions

Treatment week (sessions per week)	Power (watts)	Site & Time (minutes)	Dosage - Joules/cm <sup>2</sup>
Week 1 (6 sessions)	10	S; 15 RGT; 11	9
Week 2 (3 sessions)	10	S; 15 RGT; 11	9
Week 3 & 4 (3 sessions in each week)	7.5	S; 10 & RGT; 8	7
Week 5 & 6 (2 sessions in each week)	7.5	S; 10 & RGT; 8	7

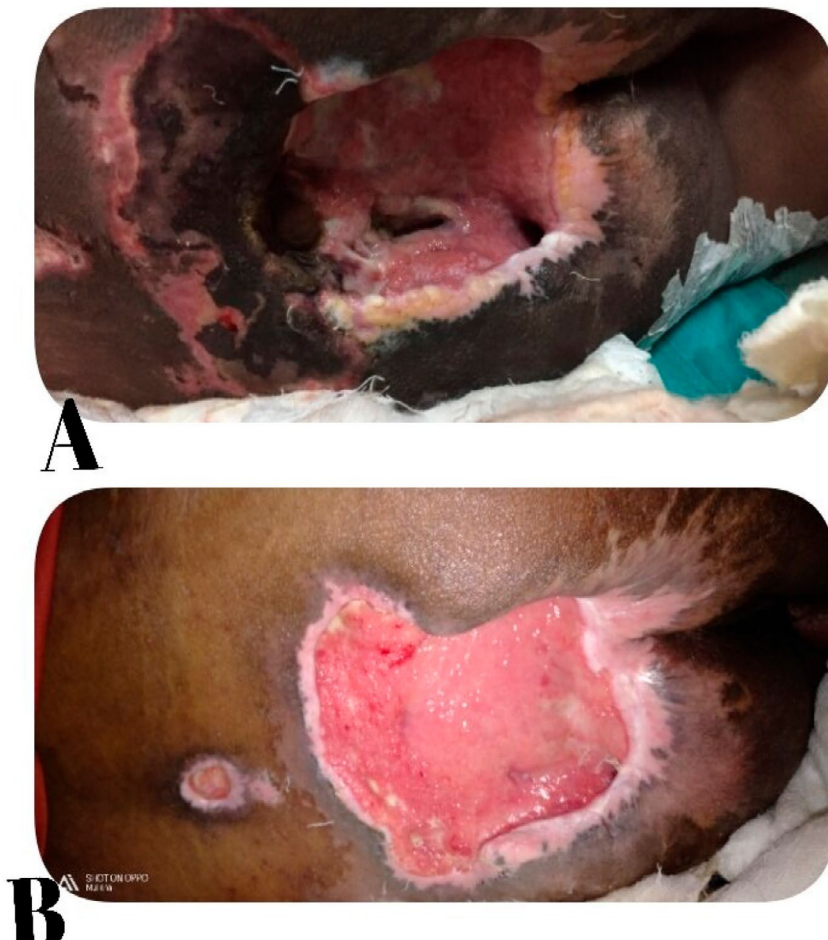
## Results

After obtaining the informed consent on the first session, the patient's demographic details, drug usage, and dietary habits were recorded. The dimensions (area) and severity stage before and after the intervention are shown in Figures 1 and 2.

### Outcome

A noticeable reduction in the area of pressure ulcers, i.e., sacral-(11.5x8.8) cm<sup>2</sup> (Fig 1B) Greater trochanter - (8.7 x 6) cm<sup>2</sup> (Fig 2B) was observed after 6 weeks of treatment.

**Figure 1.** Shows sacral pressure ulcer: (A) before and (B) after the treatment of 6 weeks



**Figure 2.** Shows a Greater trochanter pressure ulcer (A) before and (B) after the treatment of 6 weeks



**Adverse Events:** The treatment procedure was carried out with all precautions, and skin around the pressure ulcer was observed for any redness or irritation; no adverse events were recorded during the entire treatment sessions.

**Patient Perspective:** The treatment received was quite comfortable and cost-effective, as the patient did not complain of any discomfort during or after treatment sessions.

## Discussion

That is the first report to the authors' knowledge on documenting the effect of deep tissue photo-biotherapy as an intervention to PU management. Earlier, literature has shown the effect of 980 nm wavelength infrared laser therapy in an in-vitro cellular model of wound healing.<sup>9,10</sup>

In addition to the wavelength, the optimum dose of the therapeutic laser also depends upon power output and duration of application of laser to accelerate wound healing and tissue contracture.<sup>11</sup> The Class IV laser dosage in the present study uses a longer wavelength over a longer period as it produces a higher therapeutic dosage which delivers deeper into the tissue stimulating it more effectively.<sup>12</sup> A broad field of action laser therapy helps in the tissue repair process and results in increased mitotic activity, fibroblasts, collagen formation, and neovascularization of the injured tissues.<sup>13</sup>

In the present study, a magnificent reduction in pressure ulcers was encountered after 6 weeks of treating the ulcer with GaAlAs diode laser. These findings may be due to the bio-stimulatory effect of laser that influences cellular proliferation by stimulating cytochrome oxidase enzyme, which enhances oxidative phosphorylation, increases ATP production, and normalizes biological functions at a cellular level.<sup>6</sup> A similar application of laser therapy has been showing better results as an adjunct for wound healing by the mechanism of fibroblast proliferation<sup>14</sup> and collagen synthesis leading to extracellular matrix production.<sup>15</sup>



Class IV laser therapy is emerging as a non-invasive, non-pharmacological measure that helps heal pressure ulcers due to its much deeper penetration compared to low-level laser therapy. However, little literature is available on human clinical studies displaying the effect of class IV laser on wound healing.<sup>7,16</sup> Although, previous animal<sup>14</sup> and studies done on human subjects have revealed that the low wavelength of 658 nm<sup>5,13</sup> is the more effective wavelength as compared to 940nm and 808nm<sup>17</sup>, leading to an unclear effect of laser therapy. Therefore, more clinical studies on a larger sample size may be beneficial to find out the clear effects of laser therapy.

The limitation present in this report is that the PU measurement ruler method is not suitable to measure large and irregular wounds. Despite this limitation, this is the first study to demonstrate the impact of 'Class IV High-Intensity Near-Infrared Laser Therapy' for showing improvements in the PU outcomes in patients with quadriplegia.

### Future Research

A randomized controlled trial is needed to determine the effectiveness of class IV high-intensity near-infrared laser therapy compared to other interventions or placebo controls on PU.

### Conclusion

The results obtained in the report showed the positive clinical impact of class IV high-intensity near-infrared laser therapy on PU outcomes in the quadriplegia patient.

### Ethical statement

The study was done following the ethical principles for medical research involving human subjects laid by the Declaration of Helsinki, 2013. Approval for the content of photography and publication was also taken by the patient and his legal guardian (i.e., wife).

### Author contributions

Both authors conceived, designed the study, collected the data, and wrote the report.

### Competing interests

No financial, legal, or political competing interests with third parties (government, commercial, private foundation, etc.) were disclosed for any aspect of the submitted work (including but not limited to grants, data monitoring board, study design, manuscript preparation, statistical analysis, etc.).

### References

1. Edsberg LE, Black JM, Goldberg M, McNichol L, Moore L, Sieggreen M. Revised National Pressure Ulcer Advisory Panel Pressure Injury Staging System: Revised Pressure Injury Staging System. *J Wound Ostomy Continence Nurs.* 2016;43(6):585-97. <https://doi.org/10.1097/won.0000000000000281>
2. Machado RS, Viana S, Sbruzzi G. Low-level laser therapy in the treatment of pressure ulcers : systematic review. *Lasers Med Sci.* 2017;32:937-44. <https://doi.org/10.1007/s10103-017-2150-9>
3. Li Z, Lin F, Thalib L, Chaboyer W. Global prevalence and incidence of pressure injuries in hospitalised adult patients: A systematic review and meta-analysis. *Int J Nurs Stud.* 2020;105:103546. <https://doi.org/10.1016/j.ijnurstu.2020.103546>
4. Dierickx CC. The role of deep heating for noninvasive skin rejuvenation. *Lasers Surg Med.* 2006;38(9):799-807. <https://doi.org/10.1002/lsm.20446>
5. Botaro CA, Faria LA, Oliveira RG, Bruno RX, Rocha CAQC, Paiva-Oliveira EL. Low level laser therapy (GaAlInP 660 nm) in healing of a chronic venous ulcer: A case study. *Laser Phys.* 2015;25(7):075603. <http://dx.doi.org/10.1088/1054-660X/25/7/075603>
6. Alayat MS, Ali MM. Efficacy of class IV diode laser on pain and dysfunction in patients with knee osteoarthritis : a randomized placebo-control trial. *Bull Fac Phys Ther [Internet].* 2017;22(1):40-5. Available from: [https://www.researchgate.net/profile/Mohamed-Alayat/publication/315619493\\_Efficacy\\_of\\_class\\_IV\\_diode\\_laser\\_on\\_pain\\_and\\_dysfunction\\_in\\_patients\\_with\\_knee\\_osteoarthritis\\_a\\_randomized\\_placebo-control\\_trial/links/59bbaf960f7e9b48a28dd8a9/Efficacy-of-class-IV-diode-laser-on-pain-and-dysfunction-in-patients-with-knee-osteoarthritis-a-randomized-placebo-control-trial.pdf](https://www.researchgate.net/profile/Mohamed-Alayat/publication/315619493_Efficacy_of_class_IV_diode_laser_on_pain_and_dysfunction_in_patients_with_knee_osteoarthritis_a_randomized_placebo-control_trial/links/59bbaf960f7e9b48a28dd8a9/Efficacy-of-class-IV-diode-laser-on-pain-and-dysfunction-in-patients-with-knee-osteoarthritis-a-randomized-placebo-control-trial.pdf)
7. Maltese G, Karalliedde J, Rapley H, Amor T, Lakhani A, Gnudi L. A pilot study to evaluate the efficacy of class IV lasers on nonhealing neuroischemic diabetic foot ulcers in patients with type 2 diabetes. *Diabetes Care.* 2015;38(10):e152-3. <https://doi.org/10.2337/dc15-0774>

8. Keast DH, Bowering CK, Evans AW, Mackean GL, Burrows C, D'Souza L. MEASURE: A proposed assessment framework for developing best practice recommendations for wound assessment. *Wound Repair Regen.* 2004;12(3 Suppl):S1-17. <https://doi.org/10.1111/j.1067-1927.2004.0123s1.x>
9. Pereira FLC, Ferreira MVL, Mendes PS, Rossi FM, Alves MP, Alves BLP. Use of a high power laser for Wound Healing: A Case Report. *J Lasers Med Sci* 2020;11(1):112-4. <https://dx.doi.org/10.15171%2Fjms.2020.19>
10. Leclère FM, Puechguiral IR, Rotteleur G, Thomas P, Mordon SR. A prospective randomized study of 980 nm diode laser-assisted venous ulcer healing on 34 patients. *Wound Repair Regen.* 2010;18(6):580-5. <https://doi.org/10.1111/j.1524-475x.2010.00637.x>
11. Vitse J, Bekara F, Byun S, Herlin C, Teot L. A Double-Blind, Placebo-Controlled Randomized Evaluation of the Effect of Low-Level Laser Therapy on Venous Leg Ulcers. *Int J Low Extrem Wounds.* 2017;16(1):29-35. <https://doi.org/10.1177/1534734617690948>
12. Panton L, Simonavice E, Williams K, Mojock C, Kim JS, Kingsley JD, et al. Effects of Class IV laser therapy on fibromyalgia impact and function in women with fibromyalgia. *J Altern Complement Med.* 2013;19(5):445-52. <https://doi.org/10.1089/acm.2011.0398>
13. Rocha Júnior AM, Oliveira RG, Farias RE, Andrade LCF, Aarestrup FM. Modulation of fibroblast proliferation and inflammatory response by low-intensity laser therapy in tissue repair process. *An Bras Dermatol.* 2006;81(2):150-6. <https://doi.org/10.1590/S0365-05962006000200006>
14. Mun S, Cheon M, Kim SH, Choi N, Kim S, Yoo Y, et al. The effect of laser diode irradiation on wound healing of rat skin. *J Cosmet Laser Ther.* 2013;15(6):318-25. <https://doi.org/10.3109/14764172.2013.807116>
15. Kawalec JS, Reyes C, Penfield VK, Hetherinton VJ, Hays D, Feliciano F, et al. Evaluation of the Ceralas D15 diode laser as an adjunct tool for wound care: A pilot study. *Foot.* 2001;11(2):68-73. <https://doi.org/10.1054/foot.2001.0669>
16. Esmaeelinejad M, Bayat M. Effect of low-level laser therapy on the release of interleukin-6 and basic fibroblast growth factor from cultured human skin fibroblasts in normal and high glucose mediums. *J Cosmet Laser Ther.* 2013;15(6):310-7. <https://doi.org/10.3109/14764172.2013.803366>
17. Taradaj J, Halski T, Kucharzewski M, Urbanek T, Halska U, Kucio C. Effect of Laser Irradiation at Different Wavelengths (940, 808, and 658 nm) on Pressure Ulcer Healing: Results from a Clinical Study. *Evid Based Complement Alternat Med.* 2013;2013:960240. <https://doi.org/10.1155/2013/960240>