# Laser treatment of a case of lower leg lymphoedema

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This article outlines the result of introducing laser, or photobiomodulation therapy (PMBT), into the treatment protocol of a case of dependent lower limb lymphoedema. But first some PMBT background.

## Introduction

### Photobiomodulation therapy

Sunlight or heliotherapy was used by ancient Egyptians, Indians and Chinese to treat various diseases. Histories reveal therapeutic benefits of light sources used as medical treatments – for example, Florence Nightingale reportedly wheeled her patients into sunlight to assist with recovery. Michael Hamblin has written about the history of light therapy, outlining the research of its development.[1,2]

Current PBMT uses non-ionising optical radiation in the visible or near-infrared spectral range produced by laser diodes or light emitting diodes (LEDs). The phrase laser therapy can be applied when specifically referring to laser devices. However, photobiomodulation is the preferred nomenclature for what was previously referred to as low level laser, soft laser, low intensity laser, low power laser or cold laser. Hamblin et al. emphasised using this term to reduce confusion and increase consistency across research and practice.[2]

### Cellular effects of PBMT

PBMT in the treatment of lymphoedema is used for reducing harder, more fibrotic tissue, clearing drainage basin lymph nodes[3] and increasing lymphatic function.[1] Research has demonstrated that biologically, PBMT causes vasodilation of superficial lymphatics and blood vessels, increasing lymph transportation and blood flow.[2,3,4] But 3 powerful cellular effects of PBMT lead to enhanced tissue regeneration, increased lymphatic performance, and effective analgesia accelerating wound healing.[3,5]

Endogenous chromophores (light sensitive molecules) absorb PBMT to elicit photophysical and photochemical events without eliciting thermal damage. Cytochrome C oxidase, the main chromophore in cell mitochondria, absorbs light, which increases adenosine triphosphate (ATP) production resulting in more cell energy, better repair and downregulation of pain and inflammation.[3,5]

Secondly, increased nitric oxide is produced by PBMT with 2 main functions: as a vasodilator increasing lymph transportation and blood flow; and as a secondary messenger molecule leading to the activation of chemical pathways that enhance cellular repair mechanisms.[3,5,6]

PBMT also slowly and marginally upregulates the production of natural by-products of metabolism – reactive oxygen species (ROS). Low ROS concentrations have beneficial effects on cells, operating as signalling molecules that activate nucleus cellular processes that produce repair mechanisms and downregulate inflammation cycles.[3,5,6]

These effects of PBMT could therefore potentiate lymphoedema therapy to provide faster clinical outcomes of reduction of pain, inflammation and oedema.[5,6]

### Side effects and precautions

A systematic review of the safety and efficacy of PBMT found there are no known negative side effects of PBMT[7], concluding that PBMT does not influence tumours, cancer treatment outcomes or overall patient survival rates. While some patients feel a comfortable, warm sensation in the treatment area, most patients feel nothing. No pain, heat, redness, or swelling occurs during or after PBMT. However, as per guidelines, practitioners and patients must wear safety glasses for eye protection.[7]

### Variations in PBMT devices for lymphoedema

A variety of PBMT devices exist ranging from handheld Class 1, 5-Watt devices to hands-free robotised scanning Class 4, 75-Watt devices. Several differences exist between Class 1 and Class 4 lasers, including treatment time. Class 4 lasers are five times faster than Class 1 lasers, taking 18 seconds to treat a small trigger point compared with a 100-second treatment to deliver the same dose using a Class 1 laser.

In this case report, the Class 4 Multi-wave Locked System (MLS®) was used as its unique, patented synchronised laser system safely delivers a balance of two wavelengths: 905 nm pulsed emissions and 808 nm continuous emissions. The super-pulsed laser treats pain and promotes healing; the continuous emissions reduce inflammation and oedema.[9] Therefore, this device may simultaneously treat pain, inflammation, and oedema. The

optical design of the delivery system transfers energy up to 5 cm deep into the tissue without generating heat. The synchronised wave results in a synergistic effect where both the analgesic and anti-oedema effects are greater than if two single lasers had been used.[9]

## Case description

'Kirra', a 36-year-old female, has lived with a spinal cord injury since age 4, after being left a paraplegic in a car accident. Kirra mobilises full-time in a wheelchair with no movement or feeling in her legs and feet. Due to immobility, Kirra has no active muscle pump action in her lower limbs to assist lymphatic function in transporting lymph from her lower limbs and has dependent lymphoedema of her lower legs and feet. Kirra also suffers from very poor circulation, low limb tissue temperature, and severe skin dryness and cracking, which causes ulcers and chilblains to develop in colder weather.

Kirra fractured her left distal femur after falling from her chair over a year ago. She wore a full leg cast for five months, presenting to the clinic for assessment when the cast was removed, claiming her leg volume was at its greatest. According to Kirra, her orthopaedic specialist recommended amputating her left leg, which she strongly opposed. Independent in daily activities, transfers, driving, work life and leisure, Kirra asserted that amputation would significantly impact her balance when performing these life activities.

## Goals of therapy

Our goals of therapy were to:

- reduce oedema, especially in Kirra's feet, to enable shoe wearing when dressing to go out (Kirra's main goal)
- increase blood and lymphatic circulation in the lower limbs
- increase tissue temperature and reduce purple appearance of her feet
- reduce ulcer development
- enable Kirra to return to exercising in the pool by eliminating ulcers
- enable Kirra to independently don/doff compression garments.

## Treatment

Following initial assessment and traditional manual lymphatic drainage (MLD), treatment with MLS® laser therapy commenced with twice-weekly PBMT treatments in conjunction with MLD over 4 weeks, and daily home use of sequential intermittent pneumatic compression (SIPC), and night-time garments continued. This treatment followed research-based protocols established by the Limburg Oncologic Laser Institute (LOwLIght).[6]

Handheld laser was applied simultaneously to Kirra's plantar and dorsal feet, while a hands-free laser scanned her legs. The Mphi 6 robotic hands-free MLS® laser was used because the head scans larger areas, accurately setting the correct treatment area and delivering a precise

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| | Baseline (cm) | | After 4 treatment sessions (cm) | |
|---|---|---|---|---|
| **Measurement Level** | Right | Left | Right | Left |
| **MTP** | 22.5 | 25 | 22.5 | 21 |
| **TMT** | 24 | 26.5 | 23 | 24.5 |
| **Malleolus** | 24.5 | 27.5 | 22 | 23.5 |
| **10** | 27 | 31 | 24.5 | 28 |
| **20** | 30.5 | 34 | 27 | 31 |
| **30** | 30.5 | 35 | 28.5 | 32 |

*Table 1: Baseline and outcome lower limb circumferential measures*

*Figure 1: Before the introduction of MLS® laser therapy on 16/12/2021*

*Figures 2 & 3: After 1 week of MLS® laser therapy on 22/12/2021*

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dosage. MLD was performed to reduce the oedema in Kirra's feet and toes and achieve definition in her toes and ankles. Kirra wore a night-time textured compression garment to soften lymphoedema tissue throughout the day, as well as evening, with the garment worn under the pneumatic compression sleeves.

The combination of treatments reduced the volume in the lower limbs effectively, providing definition in the toes, which Kirra had not thought possible. When a considerable volume reduction was achieved, Kirra was measured for and provided with made-to-measure CCL 2 flat-knit, below knee garments, which she was able to don/doff independently.

## Results

Clinically significant reductions in limb volume were achieved (see Table 1) with visible definition in Kirra's toes (see Figures 1–3).

During treatment, there were immediate impacts on Kirra's feet with the laser: improved colour, more mobile tissue, and improved toe definition (within minutes). Over time, Kirra reported prolonged periods of warmth in her legs. Her increased circulation helped reduce ulcer and chilblain reoccurrence, and her reduced foot oedema enabled Kirra to don shoes.



The results have been life-changing. Kirra says:

> For the first time in 30-odd years, I have what resembles toes. I really didn't think that was possible after so many years! I was able to finally fit in shoes again and, as insignificant as this may sound, as a 36-year-old woman, this has been amazing for my self-esteem.

## Conclusion

Optimal patient outcomes were achieved by combination treatment using PBMT with manual lymph drainage, compression garments and SIPC pump. With the reduction of volume in her feet, Kirra was able to successfully wear shoes, her dream for 30 years, boosting her self-esteem and confidence. Knee-high daytime compression garments were made to measure for maintenance, which Kirra successfully wears independently.

Increasing amounts of scientific research and practitioner results corroborate MLS® laser therapy as an effective modality to treat lymphoedema.[10] The results of this case demonstrate the efficacy of PBMT in lymphoedema treatment. Given potential high impacts on patient quality of life, this treatment approach is worthy of further investigation via clinical trials and case reports.

## Conflicts of interest

The authors declare the following possible conflicts of interest:

Author 1 appears in a blog describing her clinical use of lasers on the Heal with Laser website – https://www.healwithlaser.com.au/blog/athletic-champion-to-laser-therapy-specialist

Authors 2 & 3 are employees of Heal with Laser.

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