

Safety of Laser Therapy

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Background

Low Level Laser Therapy (LLLT), now being termed as photobiomodulation (PBM) is the mechanism by which nonionizing optical radiation from lasers and noncoherent sources in the visible and near-infrared spectral range are absorbed by endogenous chromophores to elicit photophysical and photochemical events at various biological scales, leading to physiological changes and therapeutic effects.(Anders et al 2015) The clinical applications for this tool have evolved tremendously in a number of important areas over the 50+ years since its inception.

Classes of Laser Therapy (Riegel & Godbold 2017)

There are 4 classes of Laser therapy units based on the power of the machine, and more specifically the need for protection to the eyes or skin.

Class 1/ 1M (<0.5 mW)

- Visible & Non-visible
- No eye or skin danger
- Examples: Some pointers, car entry remotes and grocery store scanners for example
- No heating & No healing

Class 2 / 2M (< 1mW)

- Visible
- Safe for short periods of time on eyes and for extended periods of time on the skin
- Examples: Some pointers, grocery store scanners and some measuring devices

Class 3 (1mW – 500mW)

3A /3R <5mW

- Visible & Non-visible
- Pointer lasers

3B >5mW lasers

- Visible & Invisible
- Hazardous to eye (with direct viewing or 'mirror viewing')
- Minimal hazard to skin (<1 degree C.)
- Examples: Therapeutic lasers
- Eye goggles recommended

Class 4 (> 500mW)

- **4a (Therapeutic lasers) / 4b (Surgical) *Note, the classifications of 4a and 4b are not 'officially' recognized but are 'clinically' significant in regards to application & purpose of the two distinctly different class 4 laser units.**
- Increases tissue temperature
- Hazardous to eye (direct, indirect, diffuse or scattered reflection)

- Fire Hazard (may ignite combustible material)
- Eye goggles and scanning method required for application

Contraindications (Godbold & Riegel 2017, Houghton et al 2010 – unless otherwise noted)

- Over the Eye
 - Do not aim laser beams into the eyes and everyone present should wear appropriate safety spectacles. (Cotler et al 2015)
- Locally Injected medications
 - Simply wait for it to be absorbed & translocated
 - Laser induced vasodilation may alter pharmacodynamics
- Active haemorrhaging
- Over malignancy (conflicting evidence)
 - For safety – no lasering over malignancy or margins
 - *Might* be okay if tumour has been removed and margins are clear
 - Current data says “Okay to laser at sites distant to the tumour”
 - Considered useful for pain and inflammation in terminal patients
 - Owner involvement in decision to use laser is imperative!
 - *In vitro* studies show that laser might stimulate a tumour
 - *In vivo* studies have actually shown it might be beneficial
 - (Ottaviani et al 2013, Santana-Black et al 2012(a), (b), Santana-Black et al 2016, Karu 2010, Lanzafame 2011)

Precautions (Godbold & Riegel 2017)

- Active Epiphysis / Open Fontanel
 - Rodent studies have conflicting results
 - Daily laser x 21 days, changed bone length (Oliveira et al 2012)
 - Lasering every 2nd day x 21 day, changed cartilage, but not bone length (Cressoni et al 2010)
 - Clinical uses (as you would use laser normally) is likely okay
- Over the Thyroid
 - High doses (i.e. 140J/cm²) causes thyroid changes. (Parrado et al 2010)
 - Therapeutic doses (i.e. 4J/cm²) did not. (Azevedo et 2005)
- Pregnancy
 - There are no randomized controlled trials on this subject.
 - One review paper concluded, “The available evidence, limited to low evidence level case reports and series, indicates cutaneous laser treatment during pregnancy is safe for both mother and fetus.” (Wilkerson 2019)

Safety

In 2010, the Canadian Physiotherapy Association published ‘ELECTROPHYSICAL AGENTS Contraindications and Precautions: An Evidence-Based Approach to Clinical Decision Making in

Physical Therapy'. According to this document, LLLT/non-coherent light is considered to be safe to use on tissues infected with non-virulent bacteria, areas with impaired circulation, areas of impaired sensation that prevents patients from giving accurate and timely feedback, areas overlying regenerating nerves, persons with hypertension or cardiac failure, areas overlying electronic devices, intact skin overlying implants composed of metal, plastic, or cement, tissues inflamed as result of recent injury or exacerbation of chronic inflammatory condition, areas of damaged or "at risk" skin, areas affected by skin diseases, and chronic wounds, and skin overlying active epiphysis." To my knowledge, this is the first – and, possibly, only – formal guidance document of this type to address the safety of Low Level Laser Therapy/Photobiomodulation in an evidence-based manner. The recommendations for physiotherapists were, accurate and well-founded in regards to the available research at the time.

Reviews and meta-analyses of laser therapy osteoarthritis, lateral elbow tendinopathy, non-specific low back pain and other musculoskeletal disorders have demonstrated the effectiveness of this modality with no reports of adverse events or serious side effects (Stausholm et al 2019, Bjordal et al 2008, Yousefi-Nooraie 2007, Gendron & Hamblin 2019). One review paper even stated, "The adverse effects of LLLT have been reported to be no different from those reported by patients exposed to placebo devices in trials." (Cotler et al 2015)

Musculoskeletal Applications for Selected Rehabilitative Conditions

- Tendinopathy Lesions (Tumilty et al 2010, Bordvick et al 2017, Tumilty et al 2016, Haslerud et al 2017)
- Tendinopathy lesions in combination with PRP (Allahverdi et al 2015, Barbosa et al 2013, de Carvalho et al 2016)
- Wound healing (Peplow et al 2010)
- Muscle strains / Myofascial trigger points (Hsieh et al 2015, Ramos et al 2018)
- Neck Pain / Musculoskeletal Pain (Chow et al 2009, Bjordal et al 2006)
- Osteoarthritis (Stausholm et al 2019, Soleimanpour et al 2014; Alghadir et al 2014; Glazov et al 2016; Madani et al 2014, Looney et al 2018)
- Bone Healing (Rogatko et al 2017, Gomes et al 2015; Briteño-Vázquez et al 2015; Batista et al 2015)
- Nerve healing / regeneration (Shamir et al 2001; Rochkind et al 2007 a, b: Rochkind et al 2001; Barbosa et al 2010; Anders et al 2014)
- Spinal Cord Injury (Byrnes et al 2005; Wu et al 2009, Rochkind et al 2002, Draper et al 2012)
- Brain injury / degeneration (Tedford et al 2015; Ando et al 2010; Godine 2017; Quihe et al 2012; Xuan et al 2013; Oron et al 2012; Naeser et al 2011)

Laser therapy is beneficial for pain relief and can accelerate the body's ability to heal itself. Laser has a long history and strong basic science evidence, which supports its use in pain

management. It has few side effects and is well tolerated. It is clear that laser therapy is a safe and effective tool, and a valuable adjunct to rehabilitation practice.

References:

1. Allahverdi A, Sharifi D, Takhtfooladi MA, Hesaraki S, Khansari M, Dorbeh SS. Evaluation of low-level laser therapy, platelet-rich plasma, and their combination on the healing of Achilles tendon in rabbits. *Lasers Med Sci.* 2015 May;30(4):1305-13.
2. Alghadir A, Omar MT, Al-Askar AB, Al-Muteri NK. Effect of low-level laser therapy in patients with chronic knee osteoarthritis: a single-blinded randomized clinical study. *Lasers Med Sci.* 2014 Mar;29(2):749-55.
3. Anders JJ et al. In vitro and in vivo optimization of infrared laser treatment for injured peripheral nerves. *Lasers Med Surg.* 2014 46(1): 34-45.
4. Anders JJ, Lanzafame RJ, Arany PR. Low-level light/laser therapy versus photobiomodulation therapy. *Photomed Laser Surg* 2015;33:183–184.
5. Ando T et al. Comparison of therapeutic effects between pulsed and continuous wave 810nm wavelength laser irradiation for traumatic brain injury in mice. *Laser Med Surg.* 2010 42(6): 450 – 466.
6. Azevedo LH, et al. Evaluation of low intensity laser effects on the thyroid gland of male mice. *Photomed Laser Surg.* 2005, 23(6):567-570.
7. Barbosa D, de Souza RA, de Carvalho WR, Xavier M, de Carvalho PK, Cunha TC, Arisawa EÂ, Silveira L Jr, Villaverde AB. Low-level laser therapy combined with platelet-rich plasma on the healing calcaneal tendon: a histological study in a rat model. *Lasers Med Sci.* 2013 Nov;28(6):1489-94.
8. Barbosa RI, Marcolino AM, de Jesus Guirro RR, Mazzer N, Barbieri CH, de Cássia Registro Fonseca M. Comparative effects of wavelengths of low-power laser in regeneration of sciatic nerve in rats following crushing lesion. *Lasers Med Sci.* 2010 May;25(3):423-30.
9. Batista JD, Sargenti-Neto S, Dechichi P, Rocha FS, Pagnoncelli RM. Low-level laser therapy on bone repair: is there any effect outside the irradiated field?. *Lasers Med Sci.* 2015;30(5):1569-1574.
10. Bjordal JM, Johnson MI, Iversen V, Aimbire F, Lopes-Martins RA. Low-level laser therapy in acute pain: a systematic review of possible mechanisms of action and clinical effects in randomized placebo-controlled trials. *Photomed Laser Surg.* 2006 Apr;24(2):158-68.
11. Bjordal JM, Lopes-Martins RA, Joensen J, et al. A systematic review with procedural assessments and meta-analysis of low level laser therapy in lateral elbow tendinopathy (tennis elbow). *BMC Musculoskelet Disord.* 2008;9:75. Published 2008 May 29.
12. Bordvick DH et al. Penetration time profiles for two class 3B lasers *In Situ* human Achilles at rest and stretched. *Photomed Laser Surg.* 2017 35(10): 546-554.
13. Briteño-Vázquez M, Santillán-Díaz G, González-Pérez M, et al. Low power laser stimulation of the bone consolidation in tibial fractures of rats: a radiologic and histopathological analysis. *Lasers Med Sci.* 2015;30(1):333-338. doi:10.1007/s10103-014-1673-6
14. Byrnes KR, Waynant RW, Ilev IK et al. (2005) 'Light promotes regeneration and functional recovery and alters the immune response after spinal cord injury.' *Lasers Surg Med.* 36: 171 – 185.
15. Chow RT, Johnson MI, Lopes-Martins RA, Bjordal JM. Efficacy of low-level laser therapy in the management of neck pain: a systematic review and meta-analysis of randomised placebo or active-treatment controlled trials. *Lancet.* 2009 Dec 5;374(9705):1897-908.
16. Cotler HB, Chow RT, Hamblin MR, Carroll J. The Use of Low Level Laser Therapy (LLLT) For Musculoskeletal Pain. *MOJ Orthop Rheumatol.* 2015;2(5):00068.
17. Cressoni MD, Giusti HH, Pião AC, et al. Effect of GaAlAs laser irradiation on the epiphyseal cartilage of rats. *Photomed Laser Surg.* 2010 Aug;28(4):527-32.
18. de Carvalho PK, Silveira L Jr, Barbosa D, Munin E, Salgado MA, Villaverde AB. Analysis of experimental tendinitis in rats treated with laser and platelet-rich plasma therapies by Raman spectroscopy and histometry. *Lasers Med Sci.* 2016 Jan;31(1):19-26.
19. Draper, W.E., Schubert, T.A., Clemmons, R.M., Miles, S.A., Low-level laser therapy reduces time to ambulation in dogs after hemilaminectomy: a preliminary study. *Journal of Small Animal Practice.* 2012 vol. 53: 465-469.

20. Gendron DJ, Hamblin MR. Applications of Photobiomodulation Therapy to Musculoskeletal Disorders and Osteoarthritis with Particular Relevance to Canada. *Photobiomodul Photomed Laser Surg*. 2019;37(7):408-420.
21. Glazov G, Yelland M, Emery J. Low-level laser therapy for chronic non-specific low back pain: a meta-analysis of randomised controlled trials. *Acupunct Med*. 2016 Oct;34(5):328-341.
22. Godbold & Riegel. *Laser Therapy in Veterinary Medicine: Photobiomodulation*. Wiley Blackwell, Iowa, 2017.
23. Godine R. Neurological conditions. In *Laser Therapy in Veterinary Medicine: Photobiomodulation*. Riegel & Godbold eds. Wiley Blackwell, Iowa, 2017, pp 179-187.
24. Gomes FV, Mayer L, Massotti FP, et al. Low-level laser therapy improves peri-implant bone formation: resonance frequency, electron microscopy, and stereology findings in a rabbit model. *Int J Oral Maxillofac Surg*. 2015;44(2):245-251.
25. Haslerud S, Lopes-Martins RA, Frigo L, Bjordal JM, Marcos RL, Naterstad IF, Magnussen LH, Joensen J. Low-Level Laser Therapy and Cryotherapy as Mono- and Adjunctive Therapies for Achilles Tendinopathy in Rats. *Photomed Laser Surg*. 2017 Jan;35(1):32-42.
26. Houghton PE, Nussbaum EL, Hoens AM. *Physiotherapy Canada (2010) ELECTROPHYSICAL AGENTS Contraindications and Precautions: An Evidence-Based Approach to Clinical Decision Making in Physical Therapy V62/5 Special Issue*.
27. Hsieh YL, Hong CZ, Chou LW, Yang SA, Yang CC. Fluence-dependent effects of low-level laser therapy in myofascial trigger spots on modulation of biochemicals associated with pain in a rabbit model. *Lasers Med Sci*. 2015 Jan;30(1):209-16.
28. Karu T. Mitochondrial mechanisms of photobiomodulation in the context of new data about multiple roles of ATP. *Photomed Laser Surg*. 2010, 28(2): 159-160.
29. Lanzafame RJ. Photobiomodulation and cancer and other musings. *Photomed Laser Surg* 2011, 29(1): 3-4.
30. Looney AL, Huntingford JL, Blaeser LL, Mann S. A randomized blind placebo-controlled trial investigating the effects of photobiomodulation therapy (PBMT) on canine elbow osteoarthritis. *Can Vet J*. 2018 Sep;59(9):959-966.
31. Madani AS, Ahrari F, Nasiri F, Abtahi M, Tunér J. Low-level laser therapy for management of TMJ osteoarthritis. *Cranio*. 2014 Jan;32(1):38-44.
32. Naeser MA et al. Improved cognitive function after transcranial, light emitting diode treatments in chronic traumatic brain injury: two case reports. *Photomed Lasers Surg*. 2011 29(5): 351-358.
33. Oliveira SP, Rahal SC, Pereira EJ, et al. Low-level laser on femoral growth plate in rats. *Acta Cir Bras*. 2012 Feb;27(2):117-22.
34. Oron A et al. Near infrared transcranial laser therapy applied at various modes to mice following traumatic brain injury significantly reduces long-term neurological deficits. *J Neurotrauma*. 2012 29(2): 401-407.
35. Ottaviani G et al. Effect of class IV laser therapy on chemotherapy-induced oral mucositis: a clinical and experimental study. *Am J Pathol*. 2013, 183(6): 1747-1757.
36. Parrado C, et al. A quantitative investigation of microvascular changes in the thyroid gland after infrared (IR) laser radiation. *Histol Histopathol*. 1990, 14(4): 1067 – 1071.
37. Peplow PV et al. Laser photobiomodulation of wound healing: a review of experimental studies in mouse and rat animal models. *Photomed Laser Surg*. 2010 28(3): 291-325.
38. Quihe W et al. Low-level laser therapy for closed-head traumatic brain injury in mice: effect of different wavelength. *Lasers Med Surg*. 2012 44(3): 218-226.
39. Ramos et al: Characterization of Skeletal Muscle Strain Lesion Induced by Stretching in Rats: Effects of Laser Photobiomodulation. *Photomed Laser Surg*. 2018 Sep;36(9):460-467.
40. Rochkind S, Drory V, Alon M, et al. Laser phototherapy (780nm), a new modality in treatment of long-term incomplete peripheral nerve injury: a randomized double-blind placebo-controlled study. *Photomed Laser Surg* 25(5): 436 – 442, 2007.
41. Rochkind S, Leider-Trejo L, Nissan M, et al. Efficacy of 780-nm laser phototherapy on peripheral nerve regeneration after neurotube reconstruction procedure (double-blind randomized study). *Photomed Laser Surg* 25 (3): 137 – 143, 2007.
42. Rochkind S, Nissan M, Alon M et al. (2001) 'Effects of laser irradiation on the spinal cord for the regeneration of crushed peripheral nerve in rats.' *Lasers Surg Med*. 28(3): pp 216 – 219.

43. Rochkind S, Shahar A, Amon M et al. (2002) 'Transplantation of embryonal spinal cord nerve cells cultured on biodegradable microcarriers followed by low power laser irradiation for the treatment of traumatic paraplegia in rats.' *Neurol Res.* 24(4): pp 355 – 360.
44. Rogatko CP, Baltzer WI, Tennant R. Preoperative low level laser therapy in dogs undergoing tibial plateau levelling osteotomy: A blinded, prospective, randomized clinical trial. *Vet Comp Orthop Traumatol.* 2017;30(1):46-53.
45. Santana-Black L et al. Solid tumors and photobiomodulation: a novel approach to induce physiological reparative homeostasis/homeokinesis – review. *J Solid Tumors.* 2012(a), 2(6): 623-635.
46. Santana-Black L, et al. Concurrence of emerging developments in photobiomodulation and cancer. *Photomed Laser Surg,* 2012(b), 30(11):615-616.
47. Santana-Black L, et al. "Quantum leap" in photobiomodulation therapy ushers in a new generation of light-based treatments for cancer and other complex diseases: perspective and mini-review. *Photomed Laser Surg.* 2016, 34(3): 93-101.
48. Shamir MH, Rochkind S, Sandbank J et al. (2001) 'Double-blind randomized study evaluating regeneration of the rat transected sciatic nerve after suturing and postoperative low-power laser treatment" *J Reconstr Microsurg.* Feb;17(2):133-7.
49. Soleimanpour H, Gahramani K, Taheri R, et al. The effect of low-level laser therapy on knee osteoarthritis: prospective, descriptive study. *Lasers Med Sci.* 2014 Sep;29(5):1695-700.
50. Stausholm MB, Naterstad IF, Joensen J, et al. Efficacy of low-level laser therapy on pain and disability in knee osteoarthritis: systematic review and meta-analysis of randomised placebo-controlled trials. *BMJ Open.* 2019;9(10):e031142. Published 2019 Oct 28.
51. Tedford CE et al. Quantitative analysis of transcranial and intraparenchymal light penetration in human cadaver brain tissue. *Lasers Surg Med.* 2015 47(4):312-322.
52. Tumilty S, Mani R, Baxter GD. Photobiomodulation and eccentric exercise for Achilles tendinopathy: a randomized controlled trial. *Lasers Med Sci.* 2016 Jan;31(1):127-35.
53. Tumilty S, Munn J, McDonough S, Hurley DA, Basford JR, Baxter GD. Low level laser treatment of tendinopathy: a systematic review with meta-analysis. *Photomed Laser Surg.* 2010 Feb;28(1):3-16.
54. Wilkerson EC, Van Acker MM, Bloom BS, Goldberg DJ. Utilization of Laser Therapy During Pregnancy: A Systematic Review of the Maternal and Fetal Effects Reported From 1960 to 2017. *Dermatol Surg.* 2019 Jun;45(6):818-828.
55. Wu X, Dmitriev AE, Cardoso MJ, et al. 810 nm wavelength light: an effective therapy for transected or contused rat spinal cord. *Lasers Surg Med* 41 (1): 36 – 41, 2009.
56. Xuan W et al. Transcranial low level laser therapy improves neurological performance in traumatic brain injury in mice: effect of treatment repetition regimens. *PLoS One.* 2013 8(1):e53454.
57. Yousefi-Nooraie R, Schonstein E, Heidari K, et al. Low level laser therapy for nonspecific low-back pain. *Cochrane Database Syst Rev.* 2007;(2):CD005107. Published 2007 Apr 18.