

Class IV laser therapy — also termed **high-intensity laser therapy (HILT)** — uses therapeutic lasers with power output >500 mW (typically 1–25 W), distinguishing it from low-level laser therapy (LLLT, <500 mW). The higher power enables **deeper tissue penetration** while maintaining photobiomodulation effects. The strongest evidence supports its use in **musculoskeletal pain (particularly knee OA, frozen shoulder, low back pain, and neck pain), tendinopathy, and oral mucositis**, though overall evidence quality remains low to moderate across domains.

Musculoskeletal Pain — The Broadest Evidence Base

A comprehensive meta-analysis of **48 RCTs** found HILT significantly reduced pain (MD = **-1.3 cm** on VAS; 95% CI -1.6 to -1.0) and improved functionality (SMD = **-1.0**; 95% CI -1.4 to -0.7), with greater effects compared to control/no treatment than to other active conservative treatments. An umbrella review of **20 systematic reviews** (14 with meta-analyses) identified the strongest analgesic effects by condition:

- **Frozen shoulder:** MD = -2.23 cm (95% CI -3.3 to -1.2)
- **Knee osteoarthritis:** MD = -1.9 cm (95% CI -2.0 to -1.8)
- **Low back pain:** MD = -1.9 cm (95% CI -2.9 to -1.0)
- **Myofascial pain:** MD = -1.9 cm (95% CI -2.6 to -1.2)
- **Neck pain:** largest effect size (SMD = 2.1; 95% CI 1.2 to 3.0)

However, the umbrella review noted that the **methodological quality of the underlying systematic reviews was generally low to critically low** on AMSTAR-2, with key weaknesses in publication bias assessment, funding disclosure, and heterogeneity discussion.

Knee Osteoarthritis — Most Studied Condition

A network meta-analysis of 10 RCTs (n = 580) ranked HILT as having the **highest probability of being the most effective** physical therapy modality for KOA pain (SUCRA = 100%), with a significant VAS reduction of 1.66 cm versus control (95% CI 1.48–1.84). A double-blind placebo-controlled RCT (n = 40) confirmed HILT + exercise produced significantly greater improvements in VAS, WOMAC, flexion ROM, and notably **increased femoral cartilage thickness** on ultrasound at 6 weeks compared to placebo + exercise.

When compared head-to-head with LLLT in a double-blind RCT (n = 90), HILT + exercise produced **more pronounced improvements in pain, functionality, and flexion ROM** at 6 weeks, though both modalities improved cartilage thickness equally. The **AAOS Clinical Practice Guideline** for knee OA includes laser treatment with a **"Limited" strength recommendation**, acknowledging favorable pain data but downgrading for feasibility and practice usage concerns.

Low Back Pain

A meta-analysis of RCTs found HILT significantly reduced pain intensity (MD = **-1.65**; 95% CI -2.22 to -1.09; $p < 0.00001$) and improved disability on both the Oswestry (MD = -0.67) and Roland indices (MD = -1.36) compared to controls. A sham-controlled RCT using pulsed Nd:YAG laser showed significant improvements in pain, disability, and lumbar ROM after 6 weeks, while the sham group showed no change. When compared directly to LLLT in an RCT (n = 60), both modalities produced equivalent improvements in pain, disability, lumbar mobility, and quality of life — with **no significant difference between HILT and LLLT**.

Frozen Shoulder

A meta-analysis of 5 RCTs found HILT significantly reduced pain (MD = -2.23 cm on VAS) and disability (SPADI MD = -10.1%), both reaching clinical significance. However, HILT did **not improve shoulder ROM** (flexion, abduction, or external rotation) beyond conventional physical therapy. A sham-controlled RCT (n = 36) confirmed HILT was superior for pain and quality of life but not for disability or ROM.

Tendinopathy

A meta-analysis of **15 RCTs** (n = 629) found HILT significantly improved pain (MD = -1.15; 95% CI -1.73 to -0.58) and disability (SMD = -1.00) in tendinopathy, with pain reduction exceeding the MCID. Key subgroup findings:

- **Shoulder tendinopathy** showed greater disability improvement (MD = -2.54) than elbow conditions (MD = -0.91)
- **Stress pain** showed the most substantial relief (MD = -2.30)
- Treatment effects were **cumulative**, peaking after 16 weeks

For **lateral epicondylitis** specifically, a meta-analysis of 12 RCTs found both HILT and LLLT effectively reduced pain, with HILT showing **superior grip strength improvement** while LLLT demonstrated more consistent pain relief significance. Laser combined with bandage produced synergistic effects.

For **rotator cuff tendinopathy**, a systematic review found HILT showed **greater effect sizes than LLLT** for both pain (Hedges' $g = -0.701$) and disability (Hedges' $g = -0.691$), with standalone LLLT showing limited effectiveness.

HILT vs. LLLT — Head-to-Head Comparisons

A network meta-analysis of 22 RCTs ($n = 1,353$) found HILT produced statistically greater pain reduction than LLLT in some comparisons, but the magnitude was **generally modest and frequently below MCID thresholds**. Evidence for disability and ROM differences was insufficient. The certainty of evidence was **predominantly very low** per GRADE. A separate systematic review of 12 RCTs ($n = 704$) across multiple MSDs found **no statistical differences** between HILT and LLLT for pain, disability, or quality of life, concluding that neither demonstrated clear superiority.

Oral Mucositis

Class IV laser therapy showed particular promise for chemotherapy-induced oral mucositis. A clinical and experimental study demonstrated that high-power laser therapy was **more effective than low-power laser** in improving OM lesion healing, reducing inflammatory burden, preserving tissue integrity, and promoting **new arteriole formation** within granulation tissue.

Wound Healing

A service evaluation of Class IV laser (K-Laser, four wavelengths: 660/800/905/970 nm) for hard-to-heal leg ulcers found that wounds which had been **increasing in size by 0.56%/day** reversed to **decreasing by 1.12%/day** after initiating twice-weekly laser therapy, with **89.5% of patients** achieving satisfactory reduction. Cost analysis suggested positive savings, though the sample was small ($n = 19$). A narrative review of HILT in wound healing found all selected studies demonstrated favorable results, but concluded that **insufficient data** currently support HILT as a standalone wound management tool.

Mechanisms of Action

HILT produces therapeutic effects through photobiomodulation at higher power densities, enabling deeper tissue penetration (up to 10–12 cm vs. 1–3 cm for LLLT). The mechanisms include:

- **Photobiomodulation:** absorption by cytochrome c oxidase → increased mitochondrial ATP production → enhanced cellular metabolism
- **Neural inhibition:** decreased conduction velocity of A-delta and C fibers → reduced pain signal transmission
- **Anti-inflammatory:** reduced NF-κB, TNF-α, IL-6; increased anti-inflammatory mediators
- **Endorphin and serotonin release:** central pain modulation
- **Tissue repair:** enhanced fibroblast proliferation, collagen synthesis, VEGF-mediated angiogenesis

****Safety Profile**

Class IV lasers carry inherent risks due to their power classification — they can cause **permanent eye damage** from direct or diffuse beam reflections and potential skin burns, requiring mandatory protective eyewear and safety protocols. However, when used therapeutically with appropriate protocols, clinical studies consistently report **no serious adverse events**. An in vitro study confirmed high-power laser modulates mitochondrial function and redox balance **without cytotoxicity** at appropriate parameters. Skin photosensitivity episodes may occur, particularly in individuals with darker skin tones (higher melanin absorption).

References

Abdelbasset, W. K., Nambi, G., Elsayed, S. H., Alrawaili, S. M., Ataalla, N. N., Abodonya, A. M., Saleh, A. K., & Moawd, S. A. (2020). Short-term clinical efficacy of the pulsed Nd: YAG laser therapy on chronic nonspecific low back pain: A randomized controlled study. *Medicine*, 99(36), e22098.

<https://doi.org/10.1097/MD.00000000000022098>

American Academy of Orthopaedic Surgeons (2021). Management of osteoarthritis of the knee (non-arthroplasty): Evidence-based clinical practice guideline. Retrieved from

<https://www.aaos.org/globalassets/quality-and-practice-resources/osteoarthritis-of-the-knee/oak3cpg.pdf>

**Akaltun, M. S., Altindag, O., Turan, N., Gursoy, S., & Gur, A. (2021). Efficacy of high intensity laser therapy in knee osteoarthritis: a double-blind controlled randomized study. *Clinical rheumatology*, 40(5), 1989–1995.
<https://doi.org/10.1007/s10067-020-05469-7>

Arroyo-Fernández, R., Aceituno-Gómez, J., Serrano-Muñoz, D., & Avendaño-Coy, J. (2023). High-Intensity Laser Therapy for Musculoskeletal Disorders: A Systematic Review and Meta-Analysis of Randomized Clinical Trials. *Journal of clinical medicine*, 12(4), 1479. <https://doi.org/10.3390/jcm12041479>

de la Barra Ortiz, H. A., Arias Avila, M., & Liebano, R. E. (2024). Quality appraisal of systematic reviews on high-intensity laser therapy for musculoskeletal pain management: an umbrella review. *Lasers in medical science*, 39(1), 290.
<https://doi.org/10.1007/s10103-024-04241-6>

Dompe, C., Moncrieff, L., Matys, J., Grzech-Leśniak, K., Kocherova, I., Bryja, A., Bruska, M., Dominiak, M., Mozdziak, P., Skiba, T. H. I., Shibli, J. A., Angelova Volponi, A., Kempisty, B., & Dyszkiewicz-Konwińska, M. (2020). Photobiomodulation-Underlying Mechanism and Clinical Applications. *Journal of clinical medicine*, 9(6), 1724.
<https://doi.org/10.3390/jcm9061724>

Hassan, S., Humphreys, I., & Jeffery, S. (2026). The clinical and cost analysis of laser therapy for healing hard-to-heal leg ulcers: a self-control service evaluation study. *Journal of wound care*, 35(3), 268–279. <https://doi.org/10.12968/jowc.2025.0050>

**Hong, R., Lin, X., Xue, Y. S., Xu, W. R., Liu, Y. H., Li, T. C., Li, Y., & Wang, B. (2026). Effectiveness of high-intensity laser therapy for tendinopathy: a systematic review and meta-analysis of randomised controlled trials. *Lasers in medical science*, 41(1), 68.
<https://doi.org/10.1007/s10103-026-04842-3>

Lin, L. H., Chou, P. Y., Hsu, N. W., Chen, H. I., Dong, J. T., & Chen, C. C. (2026). Systematic review and meta-analysis of laser physical agent for pain and disability in rotator cuff tendinopathy: subgroup analysis and meta-regression exploration of randomized control trials. *Disability and rehabilitation*, 1–16. Advance online publication. <https://doi.org/10.1080/09638288.2026.2632917>

**Montedori A, Abraha I, Orso M, D'Errico PG, Pagano S, Lombardo G. Lasers for caries removal in deciduous and permanent teeth. Cochrane Database of Systematic Reviews 2016, Issue 9. Art. No.: CD010229. DOI: 10.1002/14651858.CD010229.pub2. Accessed 02 July 2026.

Ottaviani, G., Gobbo, M., Sturnega, M., Martinelli, V., Mano, M., Zanconati, F., Bussani, R., Perinetti, G., Long, C. S., Di Lenarda, R., Giacca, M., Biasotto, M., & Zacchigna, S. (2013). Effect of class IV laser therapy on chemotherapy-induced oral mucositis: a clinical and experimental study. *The American journal of pathology*, 183(6), 1747–1757. <https://doi.org/10.1016/j.ajpath.2013.09.003>

Wu, M., Luan, L., Pranata, A., Witchalls, J., Adams, R., Bousie, J., & Han, J. (2022). Is high intensity laser therapy more effective than other physical therapy modalities for treating knee osteoarthritis? A systematic review and network meta-analysis. *Frontiers in medicine*, 9, 956188. <https://doi.org/10.3389/fmed.2022.956188>

Zhang, M., Zhao, Z., Wu, Z., & Li, F. (2026). Is There Any Difference Between High-Intensity Laser and Low-Level Laser in the Treatment of Tennis Elbow? A Meta-analysis of Randomized Controlled Trials. *American journal of physical medicine & rehabilitation*, 105(2), 134–142. <https://doi.org/10.1097/PHM.0000000000002834>