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COLEGIO ODONTOLÓGICO COLOMBIANO

Effectiveness of photobiomodulation with low-level lasers on the acceleration of orthodontic tooth movement: A systematic review and meta-analysis of split-mouth randomized clinical trials.

Efectividad de la fotobiomodulación con láser de baja densidad de potencia en la aceleración del movimiento dental ortodóncico: una revisión sistemática y metaanálisis de ensayos clínicos aleatorizados de boca dividida.

INVESTIGADORES

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INVESTIGADOR:
Juan Camilo Méndez Sánchez

Ortodoncia y Ortopedia Maxilar
2024-II

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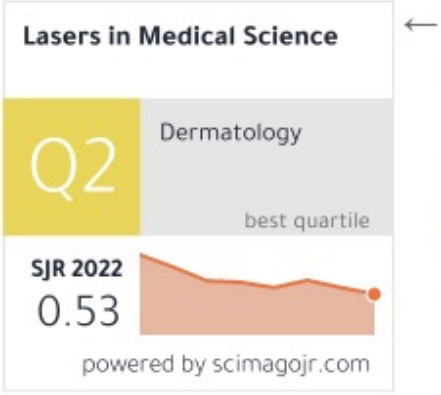

Lasers in Medical Science (2023) 38:200
https://doi.org/10.1007/s10103-023-03870-7

REVIEW ARTICLE

Check for updates

Effectiveness of photobiomodulation with low-level lasers on the acceleration of orthodontic tooth movement: a systematic review and meta-analysis of split-mouth randomised clinical trials

Marggie Grajales[1] · Nestor Ríos-Osorio[2] · Oscar Jimenez-Peña[2] · Juan Mendez-Sanchez[2] · Kelly Sanchez-Fajardo[3] · Herney Andrés García-Perdomo[4]

Received: 17 May 2023 / Accepted: 29 August 2023

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COLEGIO ODONTOLÓGICO COLOMBIANO

INTRODUCCIÓN

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

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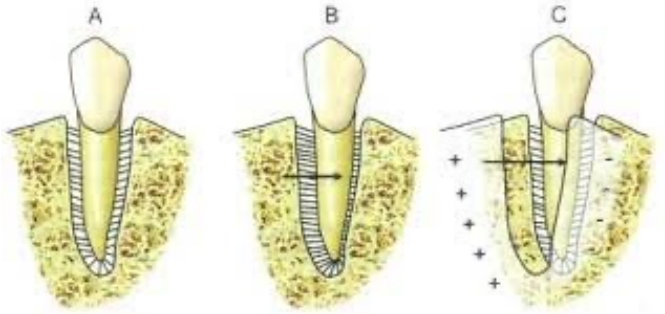
Movimiento dental ortodóncico.

Proceso inflamatorio en el ligamento periodontal (LP).

Remodelación ósea.



http://www.fodonto.uncuyo.edu.ar/upload/biomecanica-pregrado.pdf

Liberación de mediadores químicos
(2,3)

- PGE2.
- Citocinas.
- Óxido nítrico.
- Neuropéptidos - Péptido relacionado con el gen de la calcitonina (CGRP) y sustancia P (SP).

DOLOR Y DISCONFORT

TRATAMIENTOS PROLONGADOS

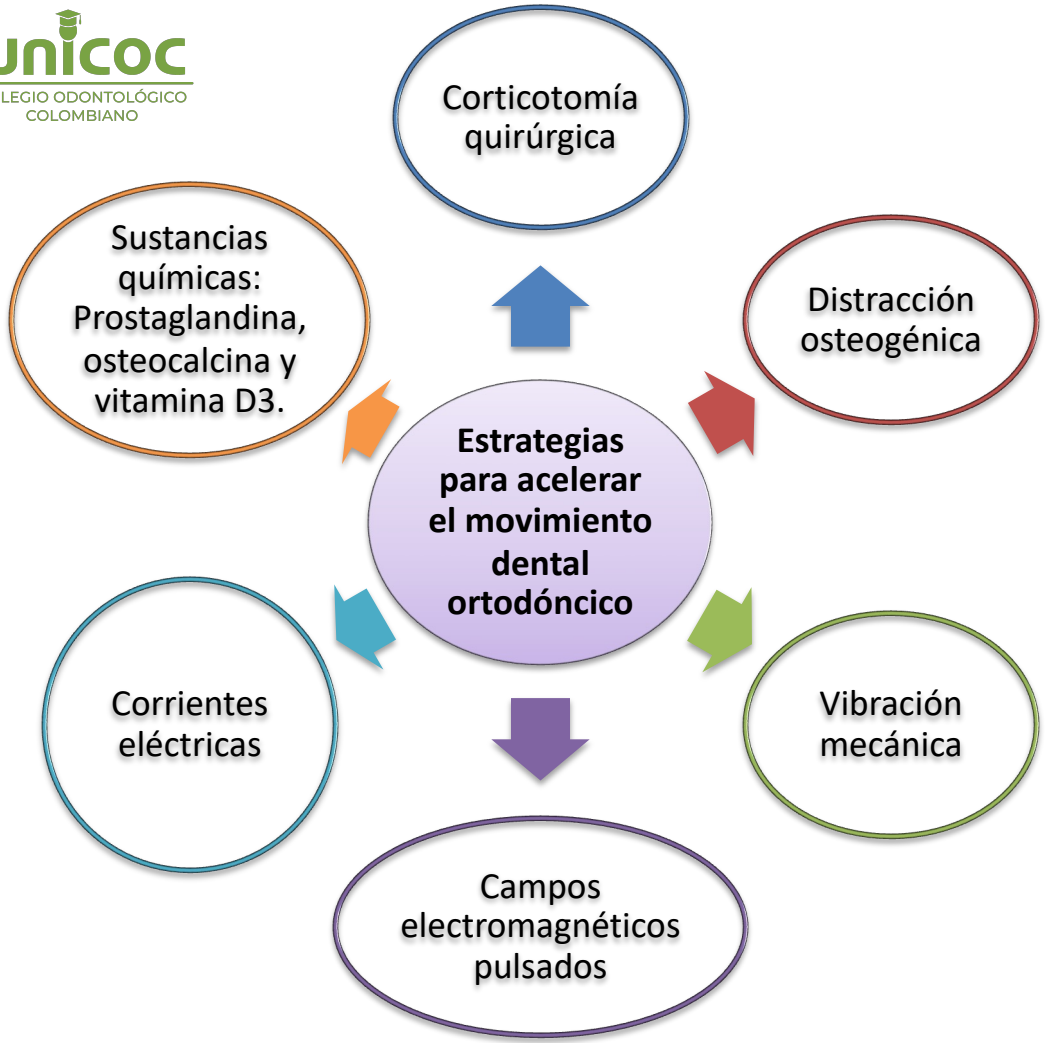
- Caries.
- Reabsorción radicular externa.
- Enfermedad periodontal.

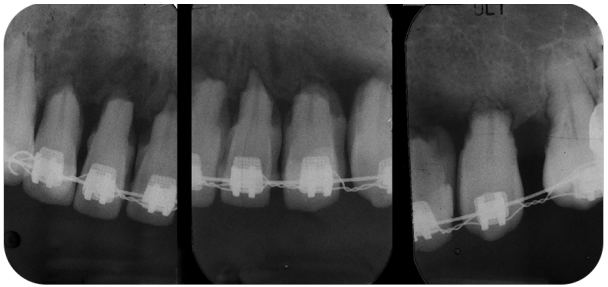
(1). Gkantidis N, Mistakidis I, Koskoura T, Padis N. Effectiveness of non-conventional methods for accelerated orthodontic tooth movement: A systematic review and meta-analysis. Journal of Dentistry. 2014;10:1300-1319.

(2). Patil AK, Shetty AS, Setty S, Thakur S. Understanding the advances in biology of orthodontic tooth movement for improved ortho-perio interdisciplinary approach. J Indian Soc Periodontol. 2013 May;17(3):309-18.

(3). Hall M, Masella R, Meister M. PDL neuron-associated neurotransmitters in orthodontic tooth movement: identification and proposed mechanism of action. Todays FDA. 2001 Feb;13(2):24-5.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.





https://radiologiaoral.wordpress.com/2013/11/28/reabsorcion-radicular-patologica-extensa-producto-de-fuerzas-de-ortodoncia-inadecuadas/

"Algunos de estos métodos se han asociado efectos adversos como reabsorción radicular y dolor intenso". **(4-8)**

(4). Long H, Pyakurel U, Wang Y, Liao L, Zhou Y, Wenli L.Interventions for accelerating orthodontic tooth movement. A systematic review. Angle Orthodontist. 2013;83:164-171.
(5). Dalaie K, Hamedi R, Kharazifard MJ, Mahdian M, Bayat M. Effect of low-level laser therapy on orthodontic tooth movement: a clinical investigation. J Dent (Tehran). 2015;12:249-256.
(6).Varella A, Revankar A, Patil A. Low-level laser therapy increases interleukin - 1B in gingival crevicular fluid and enhances the rate of orthodontic tooth movement. Am J Orthod Dentofacial Orthop. 2018;154:535-544.e5.
(7). Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low-level laser therapy on the rate of orthodontic tooth movement. Orthod Craniofacial Res. 2006;9:38-43.
(8).Yassaei S, Fekrazad R, Shahraki N. Effect of low level laser therapy on orthodontic tooth movement: a review article. J Dent (Tehran). 2013 May;10(3):264-72.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

Fotobiomodulación **(PBM)**

+

Terapia laser de baja densidad de potencia **(LLLT)**

Estrategia de aceleración del movimiento dental ortodóncico. **(8,9)**

Método no invasivo y fácil de usar. **(28)**

(28).

(8). Yassaei S, Fekrazad R, Shahraki N. Effect of low level laser therapy on orthodontic tooth movement: a review article. J Dent (Tehran). 2013 May;10(3):264-72.
(9). Tam SY, Tam VCW, Ramkumar S, Khaw ML, Law HKW, Lee SWY. Review on the Cellular Mechanisms of Low-Level Laser Therapy Use in Oncology. Front Oncol. 2020 Jul 24;10:1255.
(28). Impellizzeri A, Horodynski M, Fusco R, Palaia G, Polimeni A, Romeo U, et al. Photobiomodulation therapy on orthodontic movement: Analysis of preliminary studies with a new protocol. Int J Environ Res Public Health. 2020;17(10).

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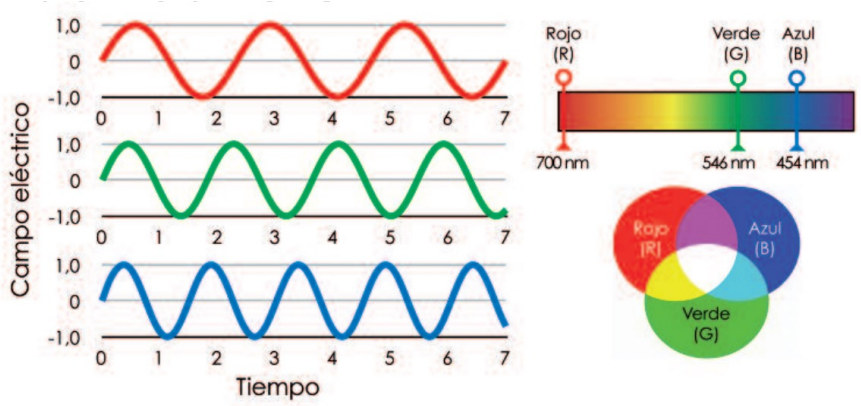
FOTOBIOMODULACIÓN (PBM)

Consiste en la aplicación de láser de diodo de baja intensidad. (9)



Modificaciones en la fisiología celular. (10)

Respuesta a esa irradiación de luz en condiciones específicas.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

(9.) Tam SY, Tam VCW, Ramkumar S, Khaw ML, Law HKW, Lee SWY. Review on the Cellular Mechanisms of Low-Level Laser Therapy Use in Oncology. Front Oncol. 2020 Jul 24;10:1255.
(10). Rola, P.; Włodarczak, S.,Lesiak, M.; Doroszko, A.;Włodarczak, A. Changes in Cell Biology under the Influence of Low-Level Laser Therapy. Photonics 2022, 9, 502.

LÁSER DE BAJA DENSIDAD DE POTENCIA (LLL)

Afecta sistemas biológicos a través de medios no térmicos. **(9,10)**

CARACTERÍSTICA	RANGO
Potencia de salida	0.001 – 0.5 Watts
Longitud de onda	500 – 1200 nm
Naturaleza de trabajo	Onda pulsada o continua
Densidad de potencia ***(irradiancia)***	5 – 5000 mW/cm^2
Densidad de energía (fluencia)	0.05-50 J/cm^2

→ Distancia entre dos puntos de una onda a otra en el eje horizontal **(nm)**.

→ Distribución de energía a través de la superficie de un tejido **(J/cm^2)**.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

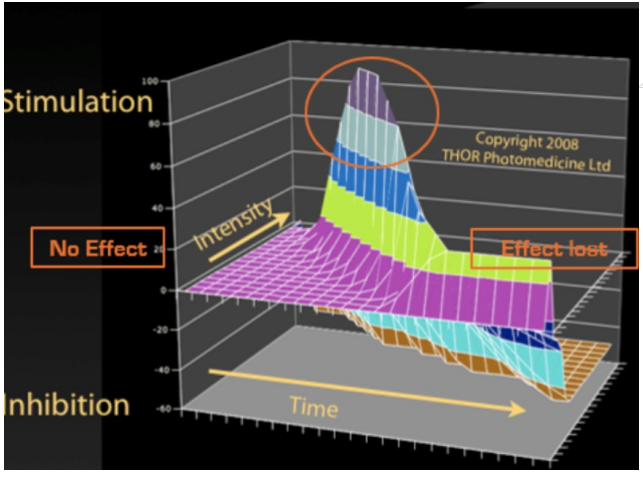
(9.) Tam SY, Tam VCW, Ramkumar S, Khaw ML, Law HKW, Lee SWY. Review on the Cellular Mechanisms of Low-Level Laser Therapy Use in Oncology. Front Oncol. 2020 Jul 24;10:1255.
(10). Rola, P.; Włodarczak, S.,Lesiak, M.; Doroszko, A.;Włodarczak, A. Changes in Cell Biology under the Influence of Low-Level Laser Therapy. Photonics 2022, 9, 502.

TERAPIA LÁSER DE BAJA DENSIDAD DE POTENCIA (LLLT)

Efectos deseados

Parámetros: Propiedades y dosis. (9,10)

Infradosificación: Respuesta celular deficiente.



Sobredosificación:

Inhibición de la proliferación celular e induce a la apoptosis.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

(9.) Tam SY, Tam VCW, Ramkumar S, Khaw ML, Law HKW, Lee SWY. Review on the Cellular Mechanisms of Low-Level Laser Therapy Use in Oncology. Front Oncol. 2020 Jul 24;10:1255.
(10). Rola, P.; Włodarczak, S.,Lesiak, M.; Doroszko, A.;Włodarczak, A. Changes in Cell Biology under the Influence of Low-Level Laser Therapy. Photonics 2022, 9, 502.

LLLT

Liberación de mediadores inflamatorios presentes en el tejido periodontal.

https://www.youtube.com/watch?v=KX9YWXMkLd8

Acelera síntesis de colágeno. **(7)**

Estimula proliferación de osteoblastos y osteoclastos.

Promueve la remodelación ósea RANKL/RANK/OPG.

(11-14)

(7). Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low-level laser therapy on the rate of orthodontic tooth movement. Orthod Craniofac Res. 2006;9(1):38-43.
(11). Yoshida T, Yamaguchi M, Utsunomiya T, Kato M, Arai Y, Kaneda T, Yamamoto H, Kasai K. Low-energy laser irradiation accelerates the velocity of tooth movement via stimulation of the alveolar bone remodeling. Orthod Craniofac Res. 2009; 12:289-298.
(12). Gama SK, Habib FA, Monteiro JS, Paraguassu GM, Araujo TM, Cangussu MC, Pinheiro AL. Tooth movement after infrared laser phototherapy: clinical study in rodents. Photomed Laser Surg. 2010;28:S79-S83.
(13). Salehi P, Heidari S, Tanideh N, Torkan S. Effect of low-level laser irradiation on the rate and short-term stability of rotational tooth movement in dogs. Am J Orthod Dentofacial Orthop. 2015;147:578-586.
(14).Fujita S, Yamaguchi Y, Utsunomiya T, Yamamoto H, Kasai K. Low-energy laser irradiation stimulates tooth movement velicity via expression of RANK and RANKL. Orthod Craniofac Res. 2008;11:143-155.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

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A Comparison of the Rate of Retraction with Low-level Laser Therapy and Conventional Retraction Technique

Abstract

Background and Ob

the treatment time re
that bone resorption
potentiates osteoclast
Low-level laser has
osteoclastic and oste
purpose of this study
tooth movement dur
experimental side wa
laser. A total of 10 in
side of the tooth. Th
gap of 3 weeks. The
caliper measurement
canine and second pr
was faster on the ex
significant ($P < 0.014$
out using an 810 nm
it is capable of increa

ORIGINAL ARTICLE CE AJO-DO

Effects of low-level laser irradiation on the rate of orthod and associated pa brackets

Irfan Qamruddin,[a] Mohammad Khurshee and Adam Husein[e]

Karachi, Pakistan, Sakaka, Kingdom of Saud

Introduction: The aim of this study w intervals on orthodontic tooth movem ligating brackets. **Methods:** Twenty-tw Class II Division 1 malocclusion were maxillary first premolars bilaterally. Aft Unitek, St Paul, Minn), a 150-g force v closed-coil springs on 0.019 x 0.025 (iLas; Biolase, Irvine, Calif) with a wa point; diameter of optical fiber tip, 0.04 roots on the experimental side; the ot at baseline and then repeated after 3 v the numeric rating scale were given to made at each visit before the applicati a CAD/CAM scanner (Planmeca, He (1.60 ± 0.38 mm) on the experiment Pain was significantly less on the expe ond visit (1.4 ± 0.82 and 1.4 ± 0.6 **Conclusions:** Low-level laser irradi movement and reduce the pain associ

International Journal of *Environmental Research and Public Health*

MDPI

Article

Photobiomodulation Therapy on Orthodontic Movement: Analysis of Preliminary Studies with a New Protocol

Alessandra Impellizzeri *, Martina Horodynski, Riccardo Fusco, Gaspare Palaia, Antonella Polimeni, Umberto Romeo, Ersilia Barbato and Gabriella Galluccio

Department of Oral and Maxillofacial Sciences, "Sapienza" University of Rome, 00161 Rome, Italy; martinahorodynski@gmail.com (M.H.); riccardo.fusco@gmail.com (R.F.); gaspare.palaia@uniroma1.it (G.P.); antonella.polimeni@uniroma1.it (A.P.); umberto.romeo@uniroma1.it (U.R.); ersilia.barbato@uniroma1.it (E.B.); gabriella.galluccio@uniroma1.it (G.G.)

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Received: 1 April 2020; Accepted: 11 May 2020; Published: 19 May 2020

check for updates

Abstract: This study aimed to investigate the effectiveness of photobiomodulation therapy (PBMT) on the acceleration of orthodontic movements, deriving from its biostimulating and regenerative capacity on soft tissues, consequent to the increase in differentiation, proliferation, and activity of cells that are involved with alveolar bone remodeling. The present randomized controlled trial was conducted on six patients who required extractive orthodontic therapy because their ectopic canines had erupted. A total of eight canines were analyzed, four of which received laser irradiation (i.e., experimental group). Two weeks after the extractions, all canines of the experimental and placebo groups were distalized simultaneously and symmetrically with the laceback retraction technique. The PBMT protocol consisted of four cycles of laser applications, one each on days 0, 3, 7, and 14 of the study, with session treatment durations of 2–4 min. The results of the descriptive analysis on the distal displacement speed of the canines after 1 month of follow-up indicate an average displacement of 1.35 mm for the non-irradiated group and 1.98 mm for the irradiated group. Through inferential analysis, a statistically significant difference ($p < 0.05$) was found between the average speed of the irradiated canines and the control canines. The low energy density laser used in this study, with the parameters set, was found to be a tool capable of statistically significantly accelerating the distal displacement of canines.

Saran Arumughan,
nju Somaiah,
nil Muddaiah,
lakrishna Shetty,
utham Reddy,
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artment of Orthodontics,
rg Institute of Dental
nces, Coorg, Karnataka,
a

28. Impellizzeri A, Horodynski M, Fusco R, Palaia G, Polimeni A, Romeo U, et al. Photobiomodulation therapy on orthodontic movement: Analysis of preliminary studies with a new protocol. Int J Environ Res Public Health. 2020;17(10).

31. Arumughan S, Somaiah S, Muddaiah S, Shetty B, Reddy G, Roopa S. A Comparison of the Rate of Retraction with Low-level Laser Therapy and Conventional Retraction Technique. Contemp Clin Dent. 2018;9(2):260–6.

34. Qamruddin I, Alam MK, Mahroof V, Fida M, Khamis MF, Husein A. Effects of low-level laser irradiation on the rate of orthodontic tooth movement and associated pain with self-ligating brackets. Am J Orthod Dentofac Orthop [Internet]. 2017;152(5):622–30.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

Lasers Med Sci
DOI 10.1007/s10103-016-2045-1

ORIGINAL ARTICLE

Effects of diode laser (98 and interleukin 6 levels i subjects

S. Yassaei[1] · H. Aghili[1] · J. Tavakol Afshari

Received: 28 October 2015 / Accepted: 5 August 2016

Abstract The aim of this study was to evaluat low-level laser irradiation on the rate of orth movement (OTM) and the interleukin-6 (IL-6 in gingival crevicular fluid (GCF) during ort ment. In this randomized split-mouth double trial, 11 female patients aged 14 to 25 ye ±4.21 year), who required canine retraction first premolars extraction, were selected. The diode laser (A.R.C. Laser GmbH, Nürnbe (980 nm, 100 mW, 5.6 J/cm², three points fr side and three from lingual side of the tooth, 5 continuous mode) was used for canine retracti maxillary quadrant (LG). The irradiation time cal and middle third of the tooth was 10 s, and 8 third of the tooth. The other maxillary quadrar control group (CG) using the laser pseudo-app side. The laser irradiation was applied on days (28 of each month during the canine retraction retraction was done using closed coil spring w

Original Article

Effects of low-intensity laser therap movement: A clinical trial

Ankur Kansal[1], Nandan Kittur[2], Vinayak Kumbhojkar[3], Kanhoba Ma

Departments of [1]Orthodontics and Dentofacial Orthopaedics, and [4]Peric Himachal Pradesh, Departments of [2]Orthodontics and Dentofacial Orth University, Belgaum, Karnataka, India

Received: October 2012
Accepted: September 2013

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ABSTRACT

Background: Low-intensity laser t of orthodontics and dentofacial o efficacy of LILT on (1) the rate of ca the radiographic changes occurrin **Materials and Methods:** A total quadrant of the upper arch was cor of the canine teeth with 150 g. Th and was also irradiated with a dio 12 mW, at 4.2 J/cm². Laser applicati day respectively during the canine r 63rd day and appliance activation w with the significance level set at *P* **Results:** Mean value obtained fro mm for laser group (LG). **Conclusion:** There was no statisti canine retraction between the LG in the radiograph following LILT.

Key Words: Bone remodeling, tooth movement

Original Article

Effect of Low-Level Laser Therapy on Orthodontic Tooth Movement: A Clinical Investigation

Kazem Dalaie[1], Roya Hamedi[2]✉, Mohammad Javad Kharazifard[3], Mina Mahdian[4], Mehrdad Bayat[4]

[1]Assistant Professor, Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[2]Postgraduate Student, Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran
[3]Epidemiologist, Dental Research Center, Dentistry Research Institute, Tehran University of Medical Sciences, Tehran, Iran
[4]Dentist, Tehran, Iran

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R. Hamedi, Department of Orthodontics, School of Dentistry, Shahid Beheshti University of Medical Sciences, Tehran, Iran

dr.r.hamedi@gmail.com

Received: 11 June 2014
Accepted: 27 January 2015

Abstract

Objectives: One major drawback of orthodontic treatment is its long duration due to slow tooth movement and the pain at the onset of treatment following application of forces. There is controversy regarding the efficacy of laser for decreasing the treatment time and pain of orthodontic treatment. The purpose of this study was to investigate the effect of low level diode laser on the rate of orthodontic tooth movement and the associated pain.

Materials and Methods: In this double blind randomized controlled clinical trial, 12 orthodontic patients referring to Shahid Beheshti School of Dentistry for first premolar extraction were randomly selected and allocated to gallium aluminum-arsenide laser (GA-AL-AS diode laser, 880 nm, 100 mW, 5 j/cm², 8 points, 80 seconds, continuous mode) or control group. The patients initially underwent leveling and alignment using the sectional system. Force (150 gr) was applied to each canine tooth via sectional closing loops. The loops were activated every month. The rate of tooth movement and pain were monitored over the treatment period and recorded on days 1, 3, 7, 30, 33, 37, 60, 63 and 67. Two-way ANOVA was used for comparison of groups.

Results: There was no significant difference in terms of tooth movement and pain scores between the irradiated and non-irradiated sides at any time point (P>0.05).

Conclusion: Although laser enhanced orthodontic tooth movement in the upper jaw, we failed to provide solid evidence to support the efficacy of laser for expediting tooth movement or reducing the associated pain.

Keywords: Orthodontic; Tooth movement; Laser Therapy, Low-Level; Pain

Journal of Dentistry, Tehran University of Medical Sciences, Tehran, Iran (2015; Vol. 12, No. 4)

5. Dalaie K, Hamedi R, Kharazifard MJ, Mahdian M, Bayat M. Effect of low-level laser therapy on orthodontic tooth movement: a clinical investigation. J Dent (Tehran). 2015;12:249-256.
36. Yassaei S, Aghili H, Afshari JT, Bagherpour A, Eslami F. Effects of diode laser (980 nm) on orthodontic tooth movement and interleukin 6 levels in gingival crevicular fluid in female subjects. Lasers Med Sci. 2016;31(9):1751–9.
37. Kansal A, Kittur N, Kumbhojkar V, Keluskar KM, Dahiya P. Effects of low-intensity laser therapy on the rate of orthodontic tooth movement: A clinical trial. Dent Res J (Isfahan). 2014;11(4):481–8.

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OBJETIVO GENERAL

Examinar críticamente la literatura científica disponible que evalúa el efecto de la LLLT en la aceleración del movimiento dental ortodóncico.

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OBJETIVOS ESPECÍFICOS

1. Evaluar los efectos clínicos de LLLT en la aceleración del movimiento dental ortodóncico.

2. Establecer la longitud de onda más efectiva del LLLT para acelerar el movimiento dental durante el tratamiento de ortodoncia.

3. Establecer la densidad de energía más efectiva del LLLT para acelerar el movimiento dental ortodóncico.

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ASPECTOS ÉTICOS Y LEGALES

Resolución 8430 de 1993.

↓

Artículo 11. Investigación sin riesgo.

↓

No aplica.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

Ministerio de Salud, RESOLUCIÓN Nº 008430 de 1993 (4 de octubre de 1993), Art. 11.

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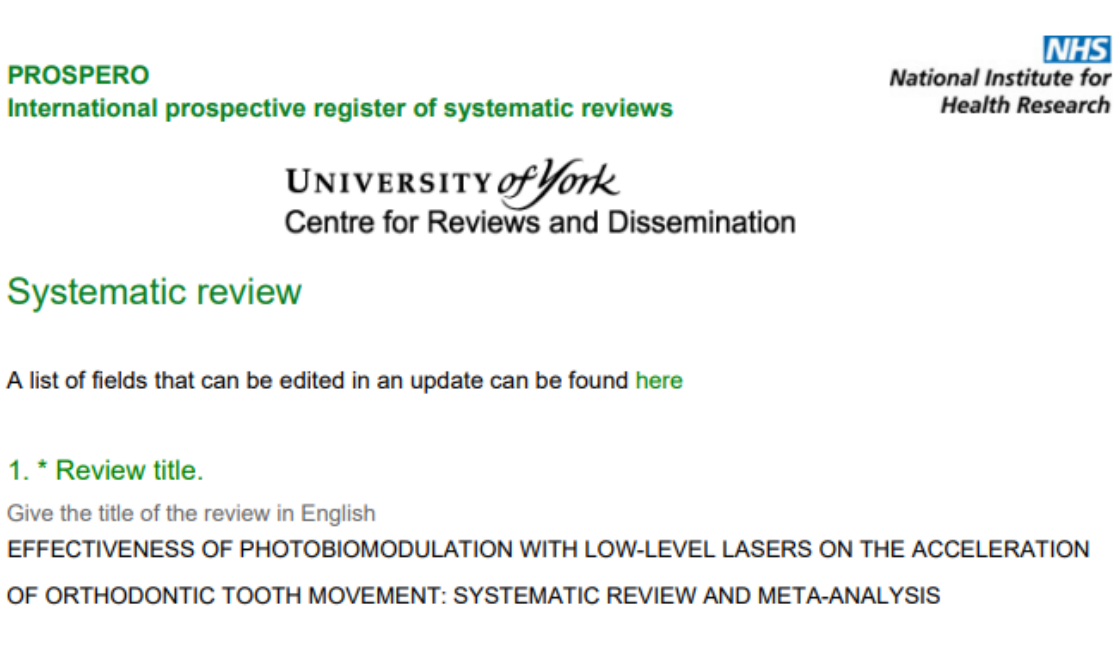
MATERIALES Y MÉTODOS

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.



PROSPERO
International prospective register of systematic reviews

NHS
National Institute for Health Research

UNIVERSITY of York
Centre for Reviews and Dissemination

Systematic review

A list of fields that can be edited in an update can be found here

1. * Review title.

Give the title of the review in English

EFFECTIVENESS OF PHOTOBIOMODULATION WITH LOW-LEVEL LASERS ON THE ACCELERATION OF ORTHODONTIC TOOTH MOVEMENT: SYSTEMATIC REVIEW AND META-ANALYSIS

Se registró un protocolo detallado de esta revisión sistemática y metaanálisis:

PROSPERO (CRD42022332585).

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

(22). Urrútia G, Bonfill X. Declaración PRISMA: una propuesta para mejorar la publicación de revisiones sistemáticas y metaanálisis [PRISMA declaration: a proposal to improve the publication of systematic reviews and meta-analyses]. Med Clin (Barc). 2010 Oct 9;135:507-11.

Siguiendo las recomendaciones del **Manual Cochrane de revisiones sistemáticas de intervenciones** y la **Declaración PRISMA.**

THE COCHRANE COLLABORATION®

PRISMA

TRANSPARENT REPORTING of SYSTEMATIC REVIEWS and META-ANALYSES

ESTRATEGIA PICO

P: Pacientes que buscaban tratamiento de ortodoncia, en los cuales estaba indicada la extracción de primeros premolares superiores y retracción de los caninos.

I: Aplicación de LLLT.

C: No se aplicó LLLT ni ninguna estrategia para acelerar el movimiento ortodóncico.

O: Aceleración del movimiento dental ortodóncico.

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

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PREGUNTA DE INVESTIGACIÓN

¿Cuál es la longitud de onda y densidad de energía en LLLT más efectiva para acelerar el movimiento dental ortodóncico en pacientes con indicación de extracción de primeros premolares superiores para retracción de caninos?

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

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CRITERIOS DE INCLUSIÓN

- RCTs en pacientes sistémicamente sanos que reportaron el efecto del LLLT en la aceleración del movimiento dental ortodóncico.
- Estudios en donde se indicó la extracción de los primeros premolares superiores con fines ortodóncicos y se realizaba la retracción de caninos.
- RCTs que describen claramente el procedimiento de ortodoncia y el protocolo de aplicación del láser.

CRITERIOS DE EXCLUSIÓN

- Estudios en los que se realizaron estrategias adicionales como la corticotomía, distracción osteogénica, vibración mecánica, campos electromagnéticos pulsados, corrientes eléctricas e inyecciones locales de sustancias químicas, entre otras, para acelerar el movimiento dental ortodóncico.
- Estudios clínicos que evaluaron la efectividad de PBM con diodo emisor de luz (LED) o láseres de alta potencia.
- Estudios clínicos donde se evalúa el efecto de la LLLT para otro tipo de movimiento ortodóncico: Mesialización de molares, alineación y nivelación dental.

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FUENTE DE INFORMACIÓN

Búsqueda bibliográfica

Sin límite de tiempo.

Recomendaciones de la **Colaboración Cochrane.**

Téminos **MeSH**, **DeCS, Emtree** y palabras relacionadas con la estrategia de búsqueda.

Bases de datos: PubMed, Scopus, ScienceDirect y LILACS.

- Artículos relevantes identificados a través de la búsqueda.
- Bases de datos de tesis.
- Open Grey
- Google Scholar
- ClinicalTrials.gov

Sin limitación de idioma.

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Appendix 1

Table 4 Search strategy translated for each database

Electronic databases	Search strategy
PubMed https://www.ncbi.nlm.nih.gov/pubmed/	"lllt" OR "laser therapy" OR "photobiomodulation" AND "tooth movement" AND "orthodontics"
ScienceDirect https://www.sciencedirect.com/	"lllt" AND "low-level laser therapy" AND "tooth movement" AND "orthodontics"
Scopus https://www.scopus.com/	*"low-level" AND "laser" AND "therapy" AND "orthodontic" AND "movement" OR "photobiomodulation" AND "tooth" AND "movement"*
LILACS http://lilacs.bvsalud.org/	"low-level laser therapy" OR "photobiomodulation" AND "tooth movement"

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RECOLECCIÓN DE DATOS

Diseño de tabla para la recolección de datos:

Autor, año de publicación, país de origen	Tamaño y características de la muestra	Rango de edad (años)	Diseño de investigación	Mecánica de retracción de caninos	Tipo de láser y λ (nm)	Densidad de energía (J/cm²)	Región anatómica de aplicación en el canino

Continuación:

Autor, año de publicación, país de origen	Frecuencia de aplicación	Velocidad de retracción del canino (promedio ± SD mm)		Resultados clínicos
		Control	Láser	

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RIESGO DE SESGO

Herramienta Cochrane Risk of Bias **(RoB-2)** para ensayos clínicos.

ANÁLISIS DE DATOS

Review Manager.

Diferencia de medias **(DM)** con sus correspondientes **IC** del **95%.**

Información se combinó con un metaanálisis de efectos aleatorios.

Prueba I^2: Valores < 50% y > 50% corresponden a niveles de heterogeneidad .

ANÁLISIS DE SUBGRUPOS

Longitud de onda **(nm)**

810 nm.

Densidad de energía **(J/cm^2)**

5.3 J/cm^2

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RESULTADOS

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SELECCIÓN DE ESTUDIOS

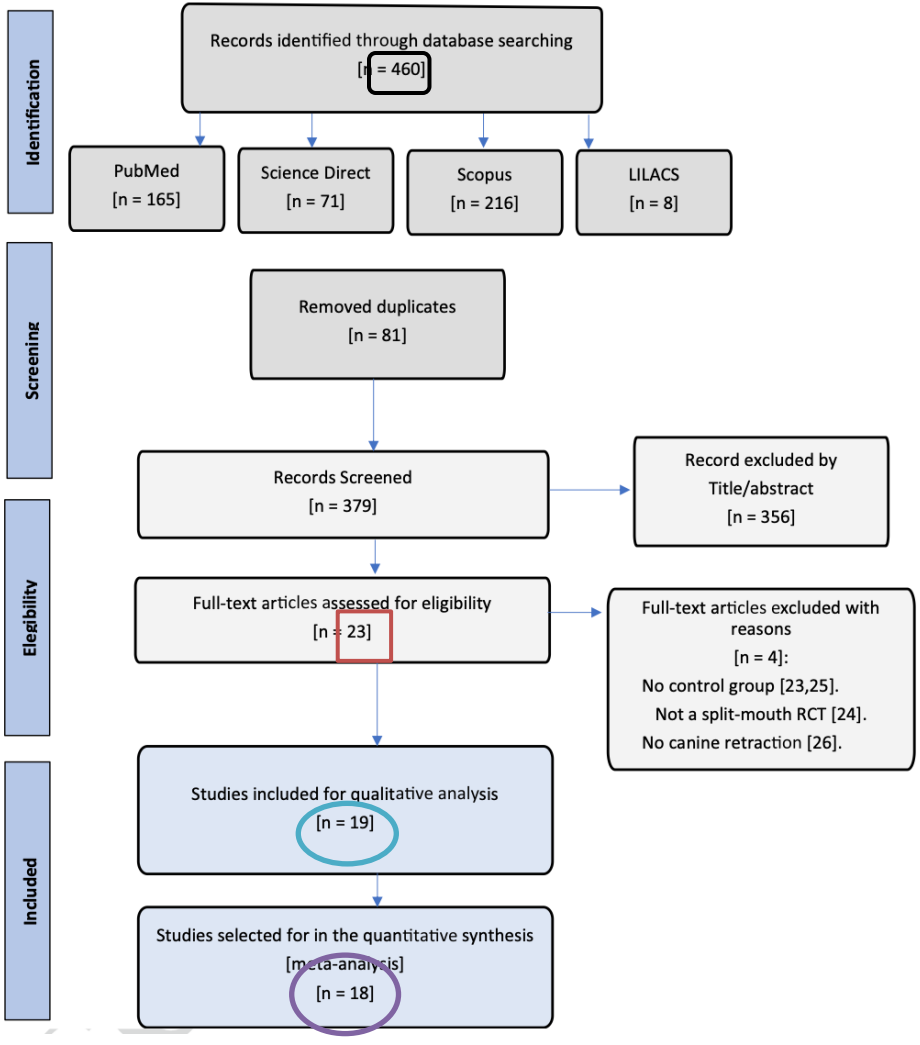

Figura 1. Diagrama de flujo de estudios incluidos, basados en la guía PRISMA.

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CARACTERÍSTICAS DE ESTUDIOS INCLUIDOS

19 estudios (2004-2021)

Países: Irán **(2),** India **(7),** Tailandia **(1),** China **(1),** Italia **(1),** Australia **(1),** Pakistán **(1),** Turquía **(1),** Brasil **(4).**

Ensayos clínicos controlados aleatorizados de boca dividida **(RCTs)**.

Periodo de seguimiento: 3 o 4 meses, lograr retracción canina completa.

Edad: 10 - 35 años.

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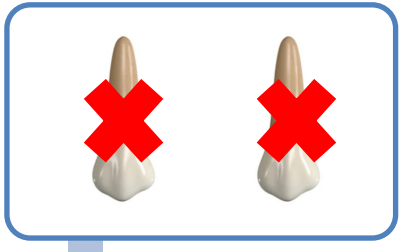
PROTOCOLO



Finalizada fase de alineación y nivelación: Retracción de caninos superiores.

Láser de diodo (GaAlAs).

Tiempo de aplicación:

3-40 segundos.

Mecánicas utilizadas: Ansas de cierre, laceback, tieback, cadenetas elastoméricas.

Sitios anatómicos:

No estandarizados.

Longitud de onda: 658-980nm.

Densidad de energía: 2-25 J/cm^2

Resortes helicoidales cerrados de Ni-Ti (barra transpalatina, botón de Nance, arco lingual, miniimplante).

(38).

33). Kochar GD, Londhe SM, Varghese B, Jayan B, Kohli S, Kohli VS. Effect of low-level laser therapy on orthodontic tooth movement. J Indian Orthod Soc. 2017;51(2):81–6.
(38). da Costa Pereira SC. Influência do laser de baixa intensidade na movimentação ortodôntica - avaliação clínica e radiográfica. Universidade de São Paulo; 2014. Tesis de doctorado. 2010 Oct 9;135:507-11.

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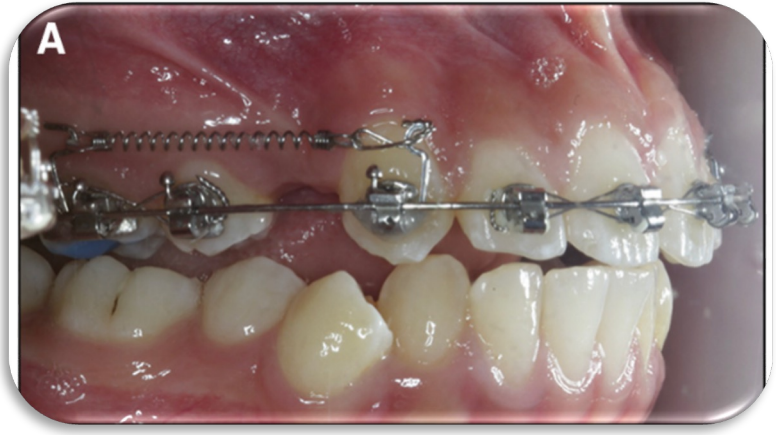
(28).



(30).

12 estudios

LLLT acelera el movimiento dental ortodóncico durante la retracción canina **(*p*<0.05).**

7 estudios

LLLT aumenta ligeramente el índice de movimiento dental **(*p*>0.05**).

(28). Impellizzeri A, Horodynski M, Fusco R, Palaia G, Polimeni A, Romeo U, et al. Photobiomodulation therapy on orthodontic movement: Analysis of preliminary studies with a new protocol. Int J Environ Res Public Health. 2020;17(10).

(30). Mistry D, Dalci O, Papageorgiou SN, Darendeliler MA, Papadopoulou AK. The effects of a clinically feasible application of low-level laser therapy on the rate of orthodontic tooth movement: A triple-blind, split-mouth, randomized controlled trial. Am J Orthod Dentofac Orthop. 2020;157(4):444–53.

Study ID	Application frequency	Canine retraction speed (average ± SD mm) Control	Laser	Clinical results
Zheng et al., 2021 China	Days 0, 7, 14, 21	Month 1: 0.85 ± 0.23	Month 1: 1.15 ± 0.29	LLLT could have clinical utility in accelerating orthodontic tooth movement due to biostimulant effects
Impellizzeri et al., 2020 Italy	Days 0, 3, 7, 14	Month 1: 1.35 ± 018	Month 1: 1.98 ± 0.33	LLLT accelerates the distal movement of the canines in a statistically significant way, 32% during month 1 of follow-up
Lalnunpuii et al., 2020 India	Days 0, 3, 7, 14 first month, and every 15 days until retraction is completed	Month 1 Right: 0.25 ± 0.48 Left: 0.5 ± 0.04	Month 1 Self-ligating right: 0.60 ± 0.4 Self-ligating left: 0.61 ± 0.9 Conventional right: 0.66 ± 0.17 Conventional left: 0.68 ± 0.23	LLLT accelerates orthodontic movement during mass retraction, regardless of bracket type
Mistry et al., 2020 Australia	Days 0, 28, 56	Month 1: 0.76 ± 0.41 Month 2: 1.55 ± 0.66 Month 3: 2.30 ± 0.86	Month 1: 0.79 ± 0.41 Month 2: 1.71 ± 0.56 Month 3: 2.55 ± 0.73	There is no significant difference on tooth movement rate by applying laser every 4 weeks
Varella et al., 2018 India	3 consecutive days. Weeks 1, 4, 8	Month 1: 0.75 ± 0.31 Month 2: 1.275 ± 0.27 Total: 2.025 ± 0.558	Month 1: 1.55 ± 0.258 Month 2: 2.90 ± 0.376 Total: 4.45 ± 0.574	Laser therapy accelerated orthodontic movement almost twice and increased the level of IL-1β
Arumughan et al., 2018 India	Days 0, 21, 42, 63	Month 3: 4.43 ± 1.022 Rate: 0.5 ± 0.242	Month 3: 3.31 ± 1.013 Rate: 0.694 ± 0.243	Laser therapy accelerates orthodontic movement by 12.55% compared to a conventional retraction technique
Guram et al., 2018 India	Weekly for 21 days	Month 2: 078 ± 0.013 Month 3: 0.87 ± 0.014 Final: 0.97 ± 0.011	Month 2: 1.17 ± 0.15 Month 3: 1.78 ± 0.28 Final: 1.97 ± 0.21	Laser therapy can increase the speed of orthodontic movement and reduce pain

Üretürk et al., 2017 Turkey	Days 0, 3, 7, 14, 21, 30, 33, 37, 44, 51, 60, 63, 67, 74, 81, 84, 90	Month 1: 0.94 ± 0.49 Month 3: 2.77 ± 1.49	Month 1: 1.32 ± 0,5 Month 3: 3.9 ± 1.41	There was a significant difference between the amount of distalization of the canine of the experimental group and the control group. The speed of tooth movement increased by average of 40%
Yassaei et al., 2016 Iran	Days 0, 7, 14, 21, 28 each month until retraction is completed	Start: 2.21 ± 0.09 Month 1: 1.99 ± 0.17 Month 2: 1.82 ± 0.27 Month 3: 1.73 ± 0.17 Month 4: 1.59 ± 0.15	Start: 2.22 ± 0.12 Month 1: 1.98 ± 0.19 Month 2: 1.77 ± 0.31 Month 3: 1.68 ± 0.20 Month 4: 1.57 ± 0.14	The efficacy of the diode laser in accelerating orthodontic tooth movement has not been demonstrated, it only increases it slightly
Dalaie et al., 2015 Iran	Days 3, 7, 30, 33, 37, 60, 63, 67	Day 3: 0.83 ± 1.23 Day 30: 2.49 ± 0.98 Day 60: 4.5 ± 0.23 Day 67: 5.72 ± 0.12	Day 3: 0.75 ± 1.32 Day 30: 2.61 ± 1.59 Day 60: 4.98 ± 0.78 Day 67: 5.79 ± 0.78	There was no significant difference between experimental and control groups
Kansal et al., 2014 India	Days 1, 3, 7, 14, 21, 28, 35, 42, 49, 56	Day 1–35: 1.762 ± 1.584 Day 35–63: 1.533 ± 0.97 Day 1–63: 3.295 ± 2.364	Day 1–35: 1.689 ± 1.201 Day 35–63: 1.845 ± 1.203 Day 1–63: 3.534 ± 2.302	No significant difference in tooth movement speed during canine retraction between both groups. No evidence of pathological changes in radiographs
Kochar et al., 2017 India	Days 0, 3, 7 each month	Month 2: 0.86 ± 0.017 Month 4: 0.92 ± 0.023 Final: 0.94 ± 0.014	Month 2: 1.13 ± 0.13 Month 4: 1.86 ± 0.86 Final: 1.92 ± 0.16	A significant difference was observed between the irradiated group and the control group
Qamruddin et al., 2017 Pakistan	Days 0, 21, 42	Month 2: 0.79 ± 0.35	Month 2: 1.60 ± 0.38	Laser therapy is beneficial, it can double the speed of orthodontic tooth movement and reduce pain at 3-week intervals

Pereira et al., 2014 Brazil	Days 30, 60, 90	Month 1: 1.90 ± 0.71 Month 2: 2.75 ± 1.42 Month 3: 1.23 ± 1.35	Month 1: 2.27 ± 0.70 Month 2: 3.05 ± 1.25 Month 3: 1.35 ± 1.11	Laser therapy was not efficient in accelerating the induced tooth movement
De souza, 2014 Brazil	Days 30, 60, 90	Month 1: 0.65 ± 0.24 Month 2: 1.52 ± 0.89 Month 3: 1.50 ± 0.55	Month 1: 0.53 ± 0.43 Month 2: 1.53 ± 0.70 Month 3: 2.08 ± 1.33	Laser therapy was not effective on tooth movement only during the first month
Doshi-Mehta et al., 2012 India	Days 0, 3, 7, 14, and 15 days	Month 3: 0.66 ± 0.55 Month 4.5: 0.84 ± 0.21	Month 3: 1.43 ± 0.15 Month 4.5: 1.17 ± 0.22	Laser therapy can be used to accelerate tooth movement. There was statistical significance
Sousa et al., 2011 Brazil	Days 0, 3, 7, 30, 33, 37, 60, 63, 67	Month 1: 0.42 ± 0.29 Month 2: 0.80 ± 0.49 Month 3: 1.60 ± 0.63	Month 1: 1.16 ± 0.51 Month 2: 2.05 ± 0.93 Month 3: 3.09 ± 1.06	The movement of laser-irradiated canines was statistically greater than control group
Limpanichkul et al., 2006 Thailand	Days 0, 1, 2 Month 1, 2, 3	Month 1: 0.38 ± 0.08 Month 2: 0.74 ± 0.13 Month 3:1.24 ± 0.21	Month 1: 0.32 ± 0.08 Month 2: 0.73 ± 0.13 Month 3:1.29 ± 0.21	Laser therapy had no effect on the speed of orthodontic tooth movement during the 3-month period
Cruz D et al., 2004 Brazil	Days 0, 3, 7, 14, 33, 37, 44	Day 60: 3.30 ± 0.24	Day 60: 4.39 ± 0.27	Canine retraction experimental group was 34% more effective than control group. Laser application accelerated orthodontic movement

λ = wavelength, expressed in nm.

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a

+ Low risk
? Some concerns
– High risk

Unique ID	Study ID	Overall	Selection of the reported result
Study 1	Arumughan et al., 2018	!	?
Study 2	Lalnunpuii et al., 2020	+	+
Study 3	Dalaie et al., 2015	!	?
Study 4	Kochar et al., 2017	!	?
Study 5	Yassaei et al., 2016	!	?
Study 6	Cruz et al., 2004	!	?
Study 7	Kansal et al., 2014	!	?
Study 8	Qamruddin et al., 2017	!	?
Study 9	Limpanichkul et al., 2006	!	?
Study 10	Doshi-Mehta et al., 2012	!	?
Study 11	Guram et al., 2018	!	?
Study 12	Pereira et al., 2014	!	?
Study 13	De Souza et al., 2014	!	?
Study 14	Sousa et al., 2011	!	?
Study 15	Zheng et al., 2021	!	+
Study 16	Varella et al., 2018	!	?
Study 17	Impellizzeri et al., 2020	!	?
Study 18	Üretürk et al., 2017	!	?
Study 19	Mistry et al., 2020	+	+

2 estudios – Bajo riesgo sesgo.

SELECCIÓN DE RESULTADO INFORMADO

16 estudios no informaron el protocolo de investigación con su plan de análisis de datos.

b

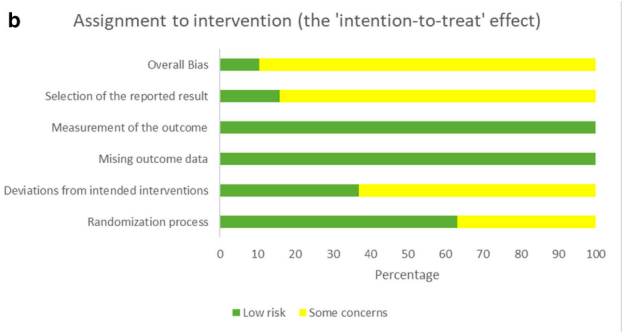

Figura 2.
a. Evaluación del riesgo de sesgo (RoB-2).
b. Datos colectivos para riesgo de sesgo, según dominios RoB-2.

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a

+ Low risk
? Some concerns
– High risk

Unique ID	Study ID	Randomization process	Deviations from intended interventions
Study 1	Arumughan et al., 2018	?	?
Study 2	Lalnunpuii et al., 2020	+	+
Study 3	Dalaie et al., 2015	+	?
Study 4	Kochar et al., 2017	?	?
Study 5	Yassaei et al., 2016	?	+
Study 6	Cruz et al., 2004	?	?
Study 7	Kansal et al., 2014	?	?
Study 8	Qamruddin et al., 2017	+	+
Study 9	Limpanichkul et al., 2006	+	?
Study 10	Doshi-Mehta et al., 2012	+	+
Study 11	Guram et al., 2018	?	+
Study 12	Pereira et al., 2014	+	?
Study 13	De Souza et al., 2014	+	?
Study 14	Sousa et al., 2011	?	?
Study 15	Zheng et al., 2021	+	?
Study 16	Varella et al., 2018	+	+
Study 17	Impellizzeri et al., 2020	+	?
Study 18	Üretürk et al., 2017	+	?
Study 19	Mistry et al., 2020	+	+

PROCESO DE ALEATORIZACIÓN

7 estudios no reportaron cómo se realizó el proceso de ocultamiento de la secuencia de asignación de los participantes a cada grupo.

DESVIACIONES DE LAS INTERVENCIONES PREVISTAS

12 estudios no informaron si se había realizado un análisis para estimar el efecto de la asignación a la intervención o una estimación de la muestra a estudiar.

b

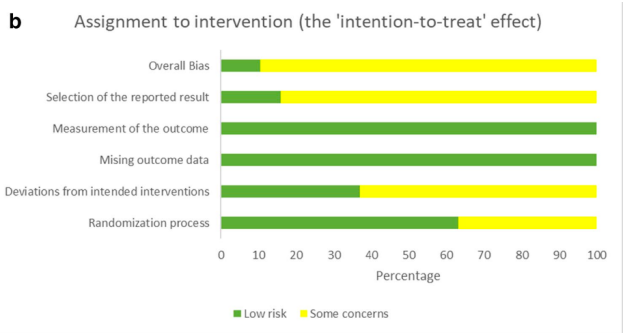

Figura 2.
a. Evaluación del riesgo de sesgo (RoB-2).
b. Datos colectivos para riesgo de sesgo, según dominios RoB-2.

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a

Unique ID	Study ID	Missing outcome data	Measurement of the outcome
Study 1	Arumughan et al., 2018	+	+
Study 2	Lalnunpuii et al., 2020	+	+
Study 3	Dalaie et al., 2015	+	+
Study 4	Kochar et al., 2017	+	+
Study 5	Yassaei et al., 2016	+	+
Study 6	Cruz et al., 2004	+	+
Study 7	Kansal et al., 2014	+	+
Study 8	Qamruddin et al., 2017	+	+
Study 9	Limpanichkul et al., 2006	+	+
Study 10	Doshi-Mehta et al., 2012	+	+
Study 11	Guram et al., 2018	+	+
Study 12	Pereira et al., 2014	+	+
Study 13	De Souza et al., 2014	+	+
Study 14	Sousa et al., 2011	+	+
Study 15	Zheng et al., 2021	+	+
Study 16	Varella et al., 2018	+	+
Study 17	Impellizzeri et al., 2020	+	+
Study 18	Üretürk et al., 2017	+	+
Study 19	Mistry et al., 2020	+	+

+ Low risk
? Some concerns
− High risk

RESULTADO FALTANTE

15 estudios no presentaron diagrama de flujo (CONSORT). Se obtuvieron resultados para todos los participantes, sin pérdidas de pacientes o resultados faltantes.

MEDICIÓN DEL RESULTADO

Métodos e instrumentos de medición adecuados y debidamente validados; diseño a boca dividida eliminó la influencia de variables biológicas.

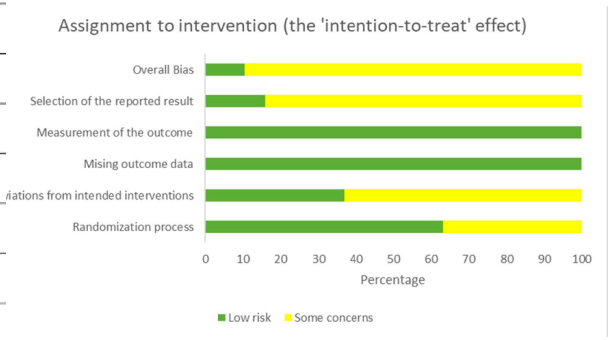

Figura 2.
a. Evaluación del riesgo de sesgo (RoB-2).
b. Datos colectivos para riesgo de sesgo, según dominios RoB-2.

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EFECTO DE LLLT EN LA ACELERACIÓN DE LA RETRACCIÓN CANINA

Study or Subgroup	Laser Mean	Laser SD	Laser Total	Control Mean	Control SD	Control Total	Weight	Mean Difference IV, Random, 95% CI
Da Costa Pereira 2014	2.27	0.7	11	1.9	0.71	11	5.9%	0.37 [−0.22, 0.96]
Dalale 2015	2.61	1.59	12	2.49	0.98	12	2.8%	0.12 [−0.94, 1.18]
De Souza 2014	0.53	0.43	11	0.65	0.24	11	9.4%	−0.12 [−0.41, 0.17]
Impellizzeri 2020	1.98	0.33	8	1.35	0.18	8	9.8%	0.63 [0.37, 0.89]
Kansal 2014	1.69	1.2	10	1.76	1.58	10	2.2%	−0.07 [−1.30, 1.16]
Limpanichkul 2006	0.32	0.08	12	0.38	0.08	12	11.6%	−0.06 [−0.12, 0.00]
Mistry 2020	0.79	0.41	21	0.76	0.41	21	10.0%	0.03 [−0.22, 0.28]
Souza 2011	1.16	0.51	10	0.42	0.29	10	8.5%	0.74 [0.38, 1.10]
Ureturk 2017	1.32	0.5	15	0.94	0.49	15	8.6%	0.38 [0.03, 0.73]
Varella 2018	1.55	0.258	10	0.75	0.31	10	9.9%	0.80 [0.55, 1.05]
Yassael 2016	1.98	0.19	11	1.99	0.17	11	11.0%	−0.01 [−0.16, 0.14]
Zheng 2021	1.15	0.29	12	0.85	0.23	12	10.4%	0.30 [0.09, 0.51]
Total (95% CI)			143			143	100.0%	0.28 [0.07, 0.48]

Heterogeneity: $Tau^2 = 0.09$; $Chi^2 = 90.64$, $df = 11$ ($P < 0.00001$); $I^2 = 88\%$
Test for overall effect: $Z = 2.67$ ($P = 0.008$)

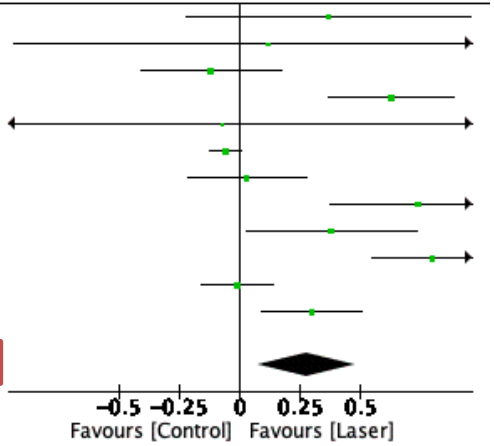

Figure 3A. Forest plot de la comparación entre lo grupos LLLT y control en el mes 1 **(12 estudios).**

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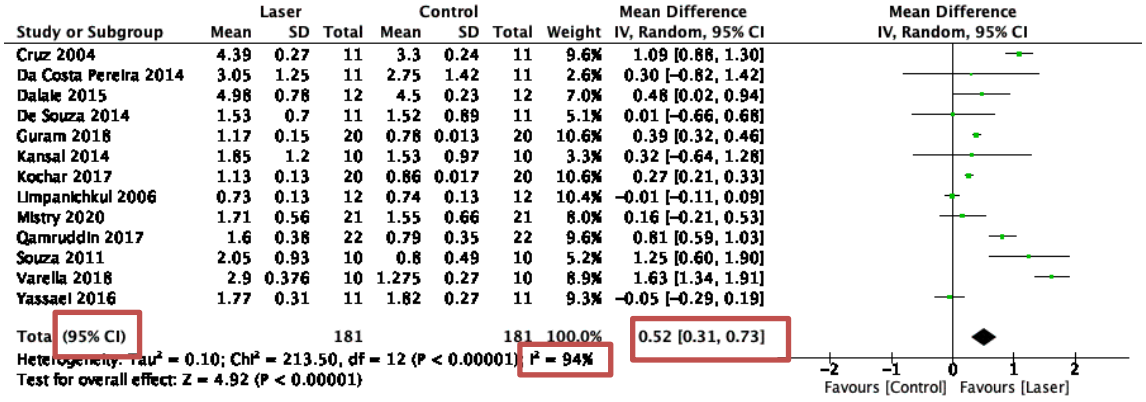

Figure 3B. Forest plot de la comparación entre lo grupos LLLT y control en el mes 2 **(13 estudios).**

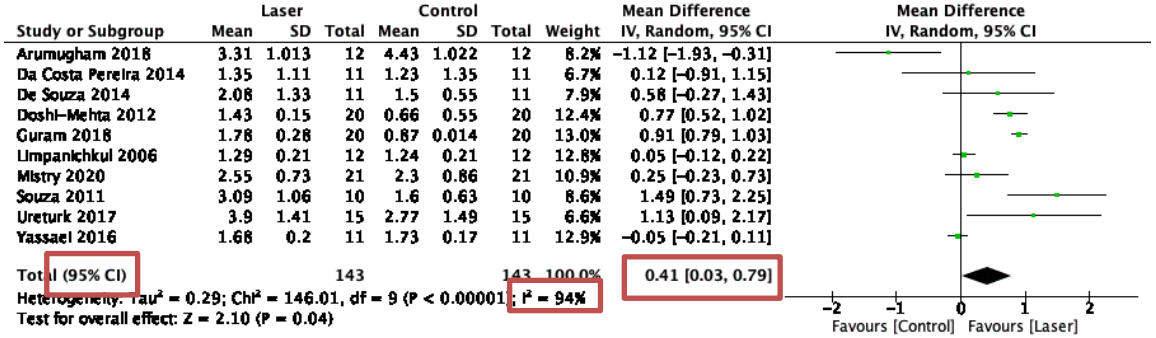

Figure 3C. Forest plot de la comparación entre lo grupos LLLT y control en el mes 3 **(10 estudios).**

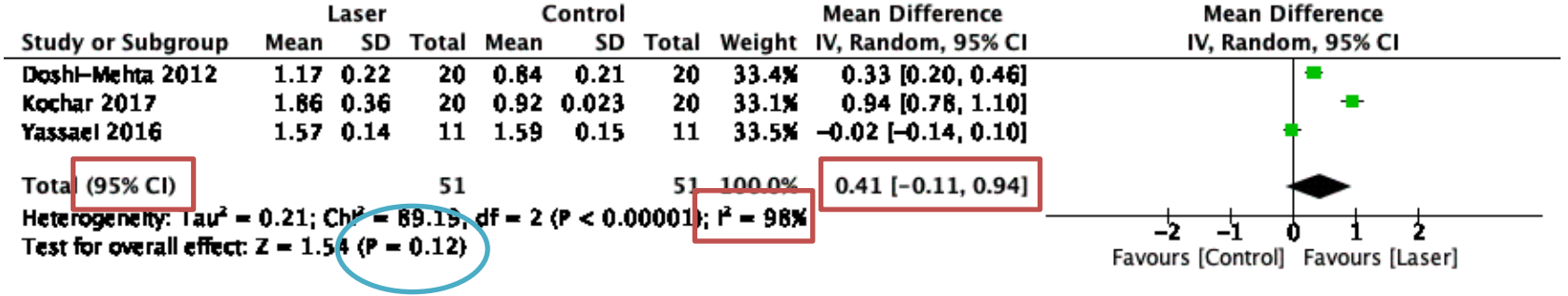

Figure 3C. Forest plot de la comparación entre lo grupos LLLT y control en el mes 4 **(3 estudios)** ($p > 0.05$).

EFECTO DE LA LONGITUD DE ONDA (λ) EN LA ACELERACIÓN DEL MOVIMIENTO DENTAL ORTODÓNCICO

≤ **810 nm** se asoció con un movimiento más rápido durante el segundo, tercer y cuarto mes de la retracción del canino superior.

Wavelength	Number of studies	MD	CI 95%	I^2
First month (≤810 nm)	5	0.24	[−0.04 to 0.51]	75%
First month (>810 nm)	7	0.3	[0.00 to 0.6]	91%
Second month (≤810 nm)	7	0.5	[0.29 to 0.72]	91%
Second month (>810 nm)	7	0.54	[−0.01 to 1.09]	97%
Third month (≤810 nm)	7	0.51	[0.13 to 0.9]	83%
Third month (>810 nm)	3	0.05	[−0.18 to 0.28]	62%
Fourth month (≤810 nm)	2	0.63	[0.04 to 1.23]	97%
Fourth month (>810 nm)	1	(−0.02)	[−0.14 to 0.1]	NA

Tabla 2. Análisis de subgrupo basado en la longitud de onda del láser.

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EFECTO DE LA DENSIDAD DE ENERGÍA *(J/cm²)* EN LA ACELERACIÓN DEL MOVIMIENTO DENTAL ORTODÓNCICO

≤ 5.3 J/cm² se asoció con un movimiento más rápido durante el primer, segundo, y cuarto mes de la retracción del canino superior.

Energy density	Number of studies	MD	CI 95%	I^2
First month (≤5.3)	5	0.56	(0.39 a 0.74)	0%
First month (>5.3)	7	0.17	(−0.05 a 0.38)	89%
Second month (≤5.3)	6	0.59	(0.36 a 0.81)	92%
Second month (>5.3)	7	0.42	(−0.07 a 0.92)	96%
Third month (≤5.3)	4	0.9	(−0.75 a 1.05)	15%
Third month (>5.3)	6	0	(−0,22 a 0.23)	54%
Fourth month (≤5.3)	2	0.63	(0.04 a 1.23)	97%
Fourth month (>5.3)	1	(−0.02)	(−0.14 a 0.1)	NA

Tabla 3. Análisis de subgrupo basado en la densidad de energía del láser.

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DISCUSIÓN

Aumento en la aceleración del movimiento dental ortodóncico en grupos tratados con **LLLT.**

Alta heterogeneidad en los estudios seleccionados; algunos no permitieron acceso público a los protocolos.

Dificultad para estimar la aleatorización o estimación de la muestra a estudiar.

Esta revisión sistemática y metaanálisis presenta un **"riesgo de sesgo moderado".**

Zheng et al (2021)

LLLT produce cambios en el metabolismo óseo, lo que podría acelerar el movimiento dental ortodóncico. **(27)**

(27). Zheng J, Yang K. Clinical research: low-level laser therapy in accelerating orthodontic tooth movement. BMC Oral Health. 2021;21(1):324.

MECANISMO CELULAR Y MOLECULAR LLLT

Remodelación ósea mediante una **reacción fotoquímica a nivel celular.**

Fotones absorbidos por las **mitocondrias.**

Aumento de la actividad enzimática de la **cCo**

Síntesis de **ATP**

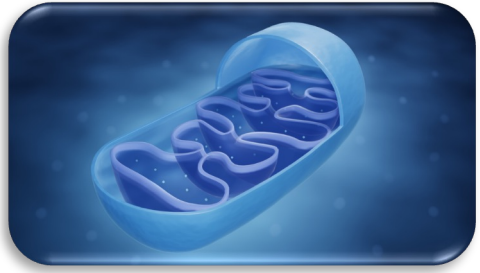
Activación de vías de señalización a través de **ROS** y **NO.**

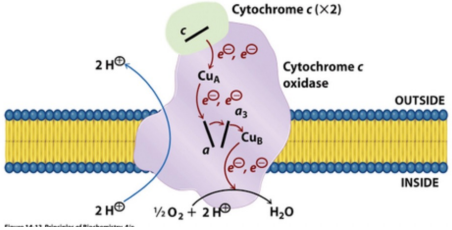
Activación de factores de transcripción

Acelera **duplicación del ADN** y la **replicación del ARN**

Activación del metabolismo celular

Vasodilatación, proliferación y diferenciación celular.





https://es.paperblog.com/complejo-iv-o-citocromo-c-oxidasa-2041740/

(5). Dalaie K, Hamedi R, Kharazifard MJ, Mahdian M, Bayat M. Effect of Low-Level Laser Therapy on Orthodontic Tooth Movement: A Clinical Investigation. J Dent (Tehran) [Internet]. 2015;12(4):249–56.
(40). Doshi-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: A clinical investigation. Am J Orthod Dentofac Orthop [Internet]. 2012;141(3):289–97.

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(28).

Los fotones emitidos por LLLT son absorbidos por la cCo y cromóforos. **(28)**

Tejidos blandos intraorales: Melanina, hemoglobina y agua.

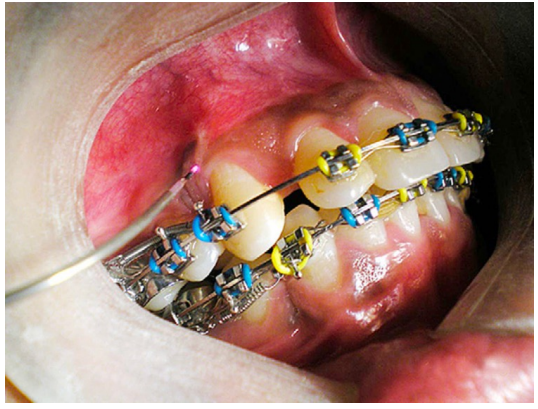
Tejidos duros dentales: Hidroxiapatita y agua. **(42, 43)**

Alta grado de penetración en las células óseas. **(45)**

(28). Impellizzeri A, Horodynski M, Fusco R, Palaia G, Polimeni A, Romeo U, et al. Photobiomodulation therapy on orthodontic movement: Analysis of preliminary studies with a new protocol. Int J Environ Res Public Health. 2020;17(10).

(42). Cruz DR, Kohara EK, Ribeiro MS, Wetter NU. Effects of low-intensity laser therapy on the orthodontic movement velocity of human teeth: A preliminary study. Lasers Surg Med. 2004;35(2):117–20.

(43). Domínguez Camacho A, Montoya Guzmán D, Velásquez Cujar SA. Effective Wavelength Range in Photobiomodulation for Tooth Movement Acceleration in Orthodontics: A Systematic Review. Photobiomodul Photomed Laser Surg. 2020 Oct;38(10):581-590.



(40).

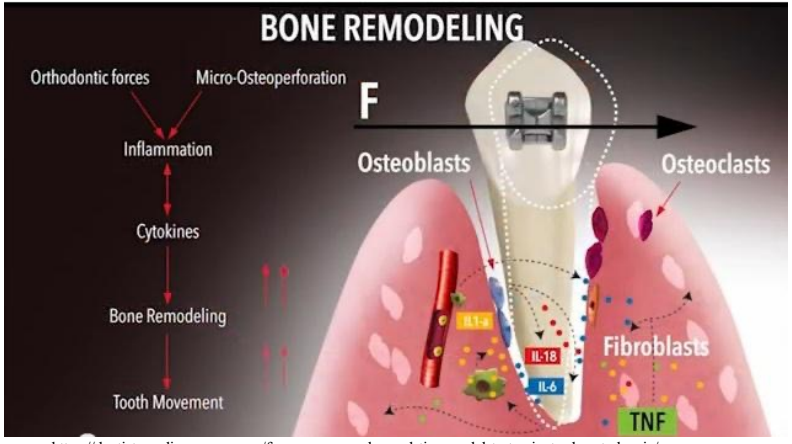
Fuerzas ortodóncicas + LLLT = Activación del sistema RANK/RANKL/OPG.

Proliferación de osteoblastos, aumento de RANKL y disminución de OPG.

> Osteoblastos = niveles de RANKL en el fluido crevicular - induce osteoclastogénesis.

Efecto favorable y no citotóxico en la remodelación ósea **(6,27,45).**

(6). Varella A, Revankar A, Patil A. Low-level laser therapy increases interleukin - 1B in gingival crevicular fluid and enhances the rate of orthodontic tooth movement. Am J Orthod Dentofacial Orthop. 2018;154:535-544.e5.
(27). Zheng J, Yang K. Clinical research: low-level laser therapy in accelerating orthodontic tooth movement. BMC Oral Health. 2021;21(1):324.
(45). Domínguez A, Velásquez SA. Acceleration of Dental Movement by Photobiomodulation: How Does It Happen? Photobiomodul Photomed Laser Surg. 2021 Jun;39(6):379-380.



https://dentistamedicasur.com.mx/formas-para-acelerar-el-tiempo-del-tratamiento-de-ortodoncia/

+ LLLT

- **Síntesis de fibronectina:** Proliferación y diferenciación de fibroblastos.
- **bFGF:** Angiogénesis y remodelación de tejidos.
- IL-1β
- IL-6
- TNF-α

=

Aceleración de movimiento dental ortodóncico. **(6,36,45)**

(6). Varella A, Revankar A, Patil A. Low-level laser therapy increases interleukin - 1B in gingival crevicular fluid and enhances the rate of orthodontic tooth movement. Am J Orthod Dentofacial Orthop. 2018;154:535-544.e5.
(36). Yassaei S, Aghili H, Afshari JT, Bagherpour A, Eslami F. Effects of diode laser (980 nm) on orthodontic tooth movement and interleukin 6 levels in gingival crevicular fluid in female subjects. Lasers Med Sci. 2016;31(9):1751–9.
(45). Domínguez A, Velásquez SA. Acceleration of Dental Movement by Photobiomodulation: How Does It Happen? Photobiomodul Photomed Laser Surg. 2021 Jun;39(6):379-380.

LONGITUD DE ONDA

≤ 810 nm

- **Domínguez, et al.** Reportaron 780 a 809 nm dosis eficiente. **(43)**
- **Karu** concluye que el mayor pico de absorción a nivel de la cCo (800 nm). **(50)**

Sousa et al., Pereira et al. Resultados contradictorios: **780 nm**, densidad de energía diferente por punto de aplicación. **(38, 41)**

(38). da Costa Pereira SC. Influência do laser de baixa intensidade na movimentação ortodôntica - avaliação clínica e radiográfica. Universidade de São Paulo; 2014. Tesis de doctorado.
2010 Oct 9;135:507-11.
(41). Sousa MV, Scanavini MA, Sannomiya EK, Velasco LG, Angelieri F. Influence of low-level laser on the speed of orthodontic movement. Photomed Laser Surg. 2011;29(3):191–6.
(43). Domínguez Camacho A, Montoya Guzmán D, Velásquez Cujar SA. Effective Wavelength Range in Photobiomodulation for Tooth Movement Acceleration in Orthodontics: A Systematic Review. Photobiomodul Photomed Laser Surg. 2020 Oct;38(10):581-590.
(50). Karu TI. Multiple roles of cytochrome c oxidase in mammalian cells under action of red and IR-A radiation. IUBMB Life. 2010;62(8):607-610.

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DENSIDAD DE ENERGÍA

≤ 5.3 J/cm²

Ge, et al. Reportaron 5 y 8 J/cm² dosis efectiva. (54)

Limpanichkul et al., utilizaron una densidad de energía de **25 J/cm²** y de 23 segundos por punto. (7)

Dosis de aplicación alta: Inhibición en la estimulación del movimiento dental ortodóncico.

(7) Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low-level laser therapy on the rate of orthodontic tooth movement. Orthod Craniofacial Res. 2006;9:38-43.
(54). Ge MK, He WL, Chen J, Wen C, Yin X, Hu ZA, Liu ZP, Zou SJ. Efficacy of low-level laser therapy for accelerating tooth movement during orthodontic treatment: a systematic review and meta-analysis. Lasers Med Sci. 2015; 30(5):1609–1618.

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CONCLUSIONES

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CONCLUSIONES

- Longitudes de onda ≤ **810 nm** y densidad de energía ≤ **5.3 J/cm²** se asocian con un aumento significativo en la aceleración del movimiento dental ortodóncico.

- Debido a la alta heterogeneidad (tamaño de muestra, edad, mecánica y configuración de irradiación) los resultados no pueden ser extrapolados.

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RECOMENDACIONES

Investigaciones futuras deben centrarse en mejorar la calidad metodológica para reducir el riesgo de sesgo y mejorar la solidez de los resultados, así como estandarizar los diferentes parámetros de aplicación láser para crear protocolos de aplicación uniformes y predecibles.

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GRACIAS

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REFERENCIAS BIBLIOGRÁFICAS

1. Gkantidis N, Mistakidis I, Koskoura T, Padis N. Effectiveness of non-conventional methods for accelerated orthodontic tooth movement: A systematic review and meta-analysis. Journal of Dentistry. 2014;10:1300-1319.
2. Patil AK, Shetty AS, Setty S, Thakur S. Understanding the advances in biology of orthodontic tooth movement for improved ortho-perio interdisciplinary approach. J Indian Soc Periodontol. 2013 May;17(3):309-18.
3. Hall M, Masella R, Meister M. PDL neuron-associated neurotransmitters in orthodontic tooth movement: identification and proposed mechanism of action. Todays FDA. 2001 Feb;13(2):24-5.
4. Long H, Pyakurel U, Wang Y, Liao L, Zhou Y, Wenli L.Interventions for accelerating orthodontic tooth movement. A systematic review. Angle Orthodontist. 2013;83:164-171.
5. Dalaie K, Hamedi R, Kharazifard MJ, Mahdian M, Bayat M. Effect of low-level laser therapy on orthodontic tooth movement: a clinical investigation. J Dent (Tehran). 2015;12:249-256.
6. Varella A, Revankar A, Patil A. Low-level laser therapy increases interleukin - 1B in gingival crevicular fluid and enhances the rate of orthodontic tooth movement. Am J Orthod Dentofacial Orthop. 2018;154:535-544.e5.
7. Limpanichkul W, Godfrey K, Srisuk N, Rattanayatikul C. Effects of low-level laser therapy on the rate of orthodontic tooth movement. Orthod Craniofacial Res. 2006;9:38-43.
8. Yassaei S, Fekrazad R, Shahraki N. Effect of low level laser therapy on orthodontic tooth movement: a review article. J Dent (Tehran). 2013 May;10(3):264-72.
9. Tam SY, Tam VCW, Ramkumar S, Khaw ML, Law HKW, Lee SWY. Review on the Cellular Mechanisms of Low-Level Laser Therapy Use in Oncology. Front Oncol. 2020 Jul 24;10:1255.
10. Rola, P.; Włodarczak, S.,Lesiak, M.; Doroszko, A.;Włodarczak, A. Changes in Cell Biology under the Influence of Low-Level Laser Therapy. Photonics 2022, 9, 502.
11. Yoshida T, Yamaguchi M, Utsunomiya T, Kato M, Arai Y, Kaneda T, Yamamoto H, Kasai K. Low-energy laser irradiation accelerates the velocity of tooth movement via stimulation of the alveolar bone remodeling. Orthod Craniofac Res. 2009; 12:289-298.
12. Gama SK, Habib FA, Monteiro JS, Paraguassu GM, Araujo TM, Cangussu MC, Pinheiro AL. Tooth movement after infrared laser phototherapy: clinical study in rodents. Photomed Laser Surg. 2010;28:S79-S83.
13. Salehi P, Heidari S, Tanideh N, Torkan S. Effect of low-level laser irradiation on the rate and short-term stability of rotational tooth movement in dogs. Am J Orthod Dentofacial Orthop. 2015;147:578-586.
14. Fujita S, Yamaguchi Y, Utsunomiya T, Yamamoto H, Kasai K. Low-energy laser irradiation stimulates tooth movement velicity via expression of RANK and RANKL. Orthod Craniofac Res. 2008;11:143-155.
15. De Almeida VL, de Andrade Gois VL, Andrade RN, Cesar CP, de Albuquerque-Junior RL, de Mello Rode S, Paranhos LR. Efficiency of low-level laser therapy within induced dental movement: A systematic review and meta-analysis. J Photochem Photobiol B. 2016;158:258-266.
17. Sonesson M, De Geer E, Subraian J, Petren S. Efficacy of low-level laser therapy in accelerating tooth movement, preventing relapse and managing acute pain during orthodontic treatment in humans: a systematic review. BMC Oral Health. 2016;17:1-12. Carvalho P, Garcia V, Kasem K, Ustrell J, Tallon V, Manzanares M. Tooth movement in orthodontic treatmentwith low-level laser therapy: systematic review of human and animal studies. Photomedicine and laser surgery. 2014;32:302-309.
18. Sousa MV, Pinzan A, Consolaro A, Henriques JF, de Freitas MR. Systematic literature review: influence of low-level laser on orthodontic movement and pain control in humans. Photomed Laser Surg. 2014;32:592-599.
19. Nimeri G, Kau C, Abou-Kheir N, Corona R. Acceleration of tooth movement during orthodontic treatment - a frontier in orthodontics. Progress in Orthodontics. 2013;14:1-8.
20. Sandoval P, Bizcar B, Navarro P, Kno¨sel M. Efficacy of diode laser therapy in acceleration of orthodontic space closure: a split-mouth randomized clinical trial. Int J Dent Oral Heal 2017;3:1–6.
21. Caccianiga G, Paiusco A, Perillo L, et al. Does low-level laser therapy enhance the efficiency of orthodontic dental alignment? Results from a randomized pilot study. Photomed Laser Surg 2017;35:421–426
22. Urrútia G, Bonfill X. Declaración PRISMA: una propuesta para mejorar la publicación de revisiones sistemáticas y metaanálisis [PRISMA declaration: a proposal to improve the publication of systematic reviews and meta-analyses]. Med Clin (Barc). 2010 Oct 9;135:507-11.
23. Eid FY, El-Kenany WA, Mowafy MI, El-Kalza AR, Guindi MA. A randomized controlled trial evaluating the effect of two low-level laser irradiation protocols on the rate of canine retraction. Sci Rep. 2022 Jun 16;12(1):10074.
24. Farhadian N, Miresmaeili A, Borjali M, Salehisaheb H, Farhadian M, Rezaei-Soufi L, Alijani S, Soheilifar S, Farhadifard H. The effect of intra-oral LED device and low-level laser therapy on orthodontic tooth movement in young adults: A randomized controlled trial. Int Orthod. 2021 Dec;19(4):612-621.
25. Türker G, Yavuz İ, Gönen ZB. Which method is more effective for accelerating canine distalization short term, low-level laser therapy or piezocision? A split-mouth study. J Orofac Orthop. 2021 Jul;82(4):236-245.
26. AlSayed Hasan MMA, Sultan K, Hamadah O. Low-level laser therapy effectiveness in accelerating orthodontic tooth movement: A randomized controlled clinical trial. Angle Orthod. 2017 Jul;87(4):499-504.
27. Zheng J, Yang K. Clinical research: low-level laser therapy in accelerating orthodontic tooth movement. BMC Oral Health. 2021;21(1):324. Available from: https://doi.org/10.1186/s12903-021-01684-z
28. Impellizzeri A, Horodynski M, Fusco R, Palaia G, Polimeni A, Romeo U, et al. Photobiomodulation therapy on orthodontic movement: Analysis of preliminary studies with a new protocol. Int J Environ Res Public Health. 2020;17(10).
29. Lalnunpuii H, Batra P, Sharma K, Srivastava A, Raghavan S. Comparison of rate of orthodontic tooth movement in adolescent patients undergoing treatment by first bicuspid extraction and en-mass retraction, associated with low level laser therapy in passive self-ligating and conventional brackets: A randomized controlled trial. Int Orthod [Internet]. 2020;18(3):412–23. Available from: https://doi.org/10.1016/j.ortho.2020.05.008
30. Mistry D, Dalci O, Papageorgiou SN, Darendeliler MA, Papadopoulou AK. The effects of a clinically feasible application of low-level laser therapy on the rate of orthodontic tooth movement: A triple-blind, split-mouth, randomized controlled trial. Am J Orthod Dentofac Orthop [Internet]. 2020;157(4):444–53. Available from: https://doi.org/10.1016/j.ajodo.2019.12.005

Grajales M, Ríos N, Jiménez O, Méndez J, Sánchez K, García H.

31. Arumughan S, Somaiah S, Muddaiah S, Shetty B, Reddy G, Roopa S. A Comparison of the Rate of Retraction with Low-level Laser Therapy and Conventional Retraction Technique. Contemp Clin Dent. 2018;9(2):260–6.

32. Guram G, Reddy KR, Dharamsi AM, Syed Ismail PM, Mishra S, Prakashkumar MD. Evaluation of Low-Level Laser Therapy on Orthodontic Tooth Movement: A Randomized. Control Study. Contemp Clin Dent. 2018;9(1):105–9.

33.Kochar GD, Londhe SM, Varghese B, Jayan B, Kohli S, Kohli VS. Effect of low-level laser therapy on orthodontic tooth movement. J Indian Orthod Soc. 2017;51(2):81–6.

34.Qamruddin I, Alam MK, Mahroof V, Fida M, Khamis MF, Husein A. Effects of low-level laser irradiation on the rate of orthodontic tooth movement and associated pain with self-ligating brackets. Am J Orthod Dentofac Orthop [Internet]. 2017;152(5):622–30.

35.Üretürk SE, Saraç M, Fıratlı S, Can ŞB, Güven Y, Fıratlı E. The effect of low-level laser therapy on tooth movement during canine distalization. Lasers Med Sci. 2017;32(4):757–64.

36.Yassaei S, Aghili H, Afshari JT, Bagherpour A, Eslami F. Effects of diode laser (980 nm) on orthodontic tooth movement and interleukin 6 levels in gingival crevicular fluid in female subjects. Lasers Med Sci. 2016;31(9):1751–9.

37.Kansal A, Kittur N, Kumbhojkar V, Keluskar KM, Dahiya P. Effects of low-intensity laser therapy on the rate of orthodontic tooth movement: A clinical trial. Dent Res J (Isfahan). 2014;11(4):481–8.

38.Pereira SCC. Influência do laser de baixa intensidade na movimentação ortodôntica - avaliação clínica e radiográfica. Universidade de São Paulo; 2014. Tesis de doctorado

39.Souza JMS. Avaliaçào da influência do Lase de Baixa Intensidade na Movimentaçào Ortodôntica e supressào da Dor. Tese [Doutorado em Ortodontia]. Facultade de Odontologia de Bauru da USP. Bauru; 2014. Tesis de doctorado

40.Doshi-Mehta G, Bhad-Patil WA. Efficacy of low-intensity laser therapy in reducing treatment time and orthodontic pain: A clinical investigation. Am J Orthod Dentofac Orthop [Internet]. 2012;141(3):289–97.

41.Sousa MV, Scanavini MA, Sannomiya EK, Velasco LG, Angelieri F. Influence of low-level laser on the speed of orthodontic movement. Photomed Laser Surg. 2011;29(3):191–6.

42.Cruz DR, Kohara EK, Ribeiro MS, Wetter NU. Effects of low-intensity laser therapy on the orthodontic movement velocity of human teeth: A preliminary study. Lasers Surg Med. 2004;35(2):117–20.

43.Domínguez Camacho A, Montoya Guzmán D, Velásquez Cujar SA. Effective Wavelength Range in Photobiomodulation for Tooth Movement Acceleration in Orthodontics: A Systematic Review. Photobiomodul Photomed Laser Surg. 2020 Oct;38(10):581-590.

44.Yamaguchi M, Hayashi M, Fujita S, et al. Low-energy laser irradiation facilitates the velocity of tooth movement and the expressions of matrix metalloproteinase-9, cathepsin K, and alpha(v) beta(3) integrin in rats. European journal of orthodontics 2010; 32:131-9.

45.Domínguez A, Velásquez SA. Acceleration of Dental Movement by Photobiomodulation: How Does It Happen? Photobiomodul Photomed Laser Surg. 2021 Jun;39(6):379-380.

46.Saygun I, Karacay S, Serdar M, Ural AU, Sencimen M, Kurtis B. Effects of laser irradiation on the release of basic fibroblast growth factor (bFGF), insulin like growth factor-1 (IGF-1), and receptor of IGF-1 (IGFBP3) from gingival fibroblasts. Lasers Med Sci. 2008 Apr;23(2):211-5.

47.Jose JA, Somaiah S, Muddaiah S, Shetty B, Reddy G, Roopa S. A Comparative Evaluation of Interleukin 1 Beta and Prostaglandin E2 with and without Low-level Laser Therapy during *En masse* Retraction. Contemp Clin Dent. 2018 Apr-Jun;9(2):267-275.

48.Smith K. The photobiological basis of low level laser therapy. Laser Ther. 1991; 3: 19-24.) (Weiner G. Laser dentistry practice management. Dent Clin North Am. 2004; 48: 1105-26

49.Hadis MA, Zainal SA, Holder MJ, Carroll JD, Cooper PR, Milward MR, Palin WM. The dark art of light measurement: accurate radiometry for low-level light therapy. Lasers Med Sci. 2016 May;31(4):789-809.

50.Karu TI. Multiple roles of cytochrome c oxidase in mammalian cells under action of red and IR-A radiation. IUBMB Life. 2010;62(8):607-610.

51.Dominguez A, Castro P, Morales M. An in vitro study of the reaction of osteoblasts to low- level laser irradiation. J Oral Laser Appl 2009;9(1):21–28.

52.Olmedo-Hernández OL, Mota-Rodríguez AN, Torres-Rosas R, Argueta-Figueroa L. Effect of the photobiomodulation for acceleration of the orthodontic tooth movement: a systematic review and meta-analysis. Lasers Med Sci. 2022; 37(5):2323–2341.

53.Li J, Ge X, Guan H, Jia L, Chang W, Ma W. The effectiveness of photobiomodulation on accelerating tooth movement in orthodontics: a systematic review and meta-analysis. Photobiomodul Photomed Laser Surg. 2021; 39(4):232–244.

54.Ge MK, He WL, Chen J, Wen C, Yin X, Hu ZA, Liu ZP, Zou SJ. Efficacy of low-level laser therapy for accelerating tooth movement during orthodontic treatment: a systematic review and meta-analysis. Lasers Med Sci. 2015; 30(5):1609–1618

55.Ruan MJ, Chen G, Xu TM. Comparison of orthodontic tooth movement between adolescents and adults based on implant superimposition. PLoS One. 2018;13(5):e0197281.

56.Iwasaki LR, Liu Y, Liu H, Nickel JC. Speed of human tooth movement in growers and non- growers: Selection of applied stress matters. Orthod Craniofac Res. 2017;20 Suppl 1:63-67.

57.Khalid Z, Bangash AA, Anwar A, Pasha H, Amin E. Canine Retraction Using a Closed Nickel Titanium Coil Spring and an Elastic Module. J Coll Physicians Surg Pak. 2018;28(9):695- 698.