Appendix 1. 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"

Table 1. Characteristics and main results of the included studies

Study ID	Sample size and characteristics	Age range (years)	Canine retraction mechanics	Laser type and λ (nm)	Energy density (J/cm2)	Anatomical application points on canine/ Application time
Zheng et al., 2021 China	8 female 4 male	18-28	NiTi closed spring Transpalatal arch	GaAls 810nm	6.3	Buccal-medial Buccal-distal Palatal-medial Palatal-distal *40 seconds each point
Impellizzeri et al., 2020 Italy	8 canines studied; no gender specified.	14-18	Laceback	GaAlAs 910/650	2	Buccal and palatal surfaces: 1/3 cervical 1/3 middle 1/3 apical *10 seconds each point
Lalnunpuii et al., 2020 India	41 female 24 male	13-20	Tieback (mass retraction)	GaAlAs 658	2.3	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Central *10 seconds each point
Mistry et al., 2020 Australia	14 female 7 male	13-23	NiTi closed spring Nance appliance	GaAlAs 808	Not reported	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Varella et al., 2018 India	6 female 4 male	14-25	NiTi closed spring	GaAlAs 940	8	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Arumughan et al., 2018 India	12 patients, no gender specified.	17-35	NiTi closed spring (mass retraction)	GaAlAs 810	10	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Guram et al., 2018 India	12 female 8 male	17-24	Sectional closure loops.	GaAlAs 810	5	Buccal and palatal surfaces: 1/3 cervical 1/3 middle 1/3 apical *10 seconds each point
Kochar et al., 2017 India	8 female 12 male	16-24	NiTi closed spring Nance button	GaAlAs 810	5	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Qamruddin et al., 2017 Pakistan	11 female 11 male	12-25	NiTi closed spring	GaAlAs 940	7.5	Buccal and palatal surfaces: 1/3 cervical: mesial and distal 1/3 middle: Central 1/3 apical: Medial and distal *3 seconds each point

Üretürk et al., 2017 Turkey	8 female 7 male	12-19	NiTi closed spring Mini-screws	GaAlAs 820	5	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *3 seconds each point
Yassaei et al., 2016 Iran	11 female	14-25	NiTi closed spring Transpalatal arch	GaAlAs 980	5.6	Buccal and palatal surfaces: 1/3 cervical 1/3 middle *10 seconds each point 1/3 apical *8 seconds each point
Dalaie et al., 2015 Iran	9 female 3 male	20.1 Average	Sectional closure loops	GaAlAs 880	5	Distal-buccal and distal-palatal surfaces: 1/3 cervical 1/3 middle 1/3 apical *10 seconds each point
Kansal et al.. 2014 India	10 patients, no gender specified.	No mentioned	Elastomeric chain	GaAS 904	4.2	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Pereira et al., 2014 Brazil	7 male 4 female	12-17	NiTi closed spring Transpalatal arch	GaAlAs 780	10	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle 1/3 apical: Medial and distal *10 seconds each point
De soouza ., 2014 Brazil	11 patients, no gender specified.	No mentioned	NiTi closed spring Transpalatal arch	GaAlAs 780	10	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Doshi-Mehta et al., 2012 India	12 female 8 male	12-23	NiTi closed spring Transpalatal arch	GaAlAs 810	5	Buccal and palatal surfaces: 1/3 cervical: Medial and distal 1/3 middle: Central 1/3 apical: Medial and distal *10 seconds each point
Sousa et al., 2011 Brazil	6 female 4 male	10.5-20.2	NiTi closed spring	Ga AlAs 780	5	Buccal and palatal surfaces: 10 points *10 seconds each point
Limpanichkul et al., 2006 Thailand	8 female 4 male	20.11 ± 3.4 Average	NiTi closed spring	GaAlAs 860	25	Buccal and palatal surfaces: 1/3 cervical 1/3 middle 1/3 apical Two points on distal canine *23 seconds each point
Cruz et al., 2004 Brazil	11 patients	12-18	NiTi closed spring Transpalatal arch Modified Nance appliance	GaAlAs 780	5	1/3 Cervical: Mesial and distal 1/3 Middle: central 1/3 apical: Mesial and distal * Buccal and palatine surfaces, 10s each point

λ= wavelength, expressed in nm.

Table 1. Continued

Study ID	Application frequency	Canine retraction speed (average ± SD mm)		Clinical results
		Control	Laser	
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	Month1 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.
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.
Üretürk et al., 2017 Turkey	Dias 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.

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	Dias 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.

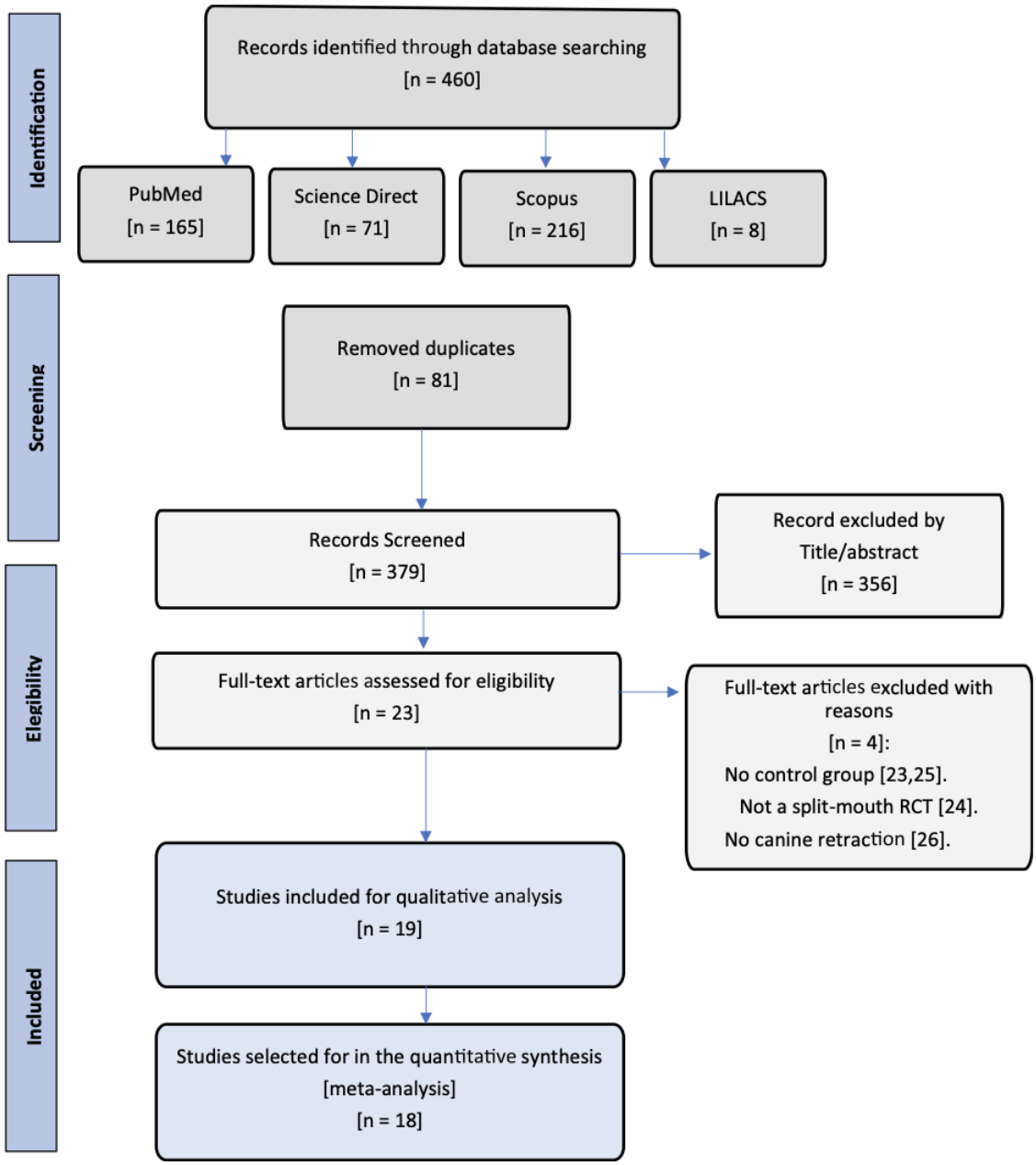
Table 2. Subgroup analysis based on laser wavelength. MDs, mean Differences

Wavelength	Number of studies	MDs	IC95%	I2
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 (≤810nm)	7	0.5	[0.29 to 0.72]	91%
Second month (>810nm)	7	0.54	[-0.01 to 1.09]	97%
Third month (≤810nm)	7	0.51	[0.13 to 0.9]	83%
Third month (>810nm)	3	0.05	[-0.18 to 0.28]	62%
Fourth month (≤810nm)	2	0.63	[0.04 to 1.23]	97%
Fourth month (>810nm)	1	(-0.02)	[-0.14 to 0.1]	NA

Table 3. Subgroup analysis based on laser energy density.

Energy density	Number of studies	MD	IC95%	I2
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

Figure 1. Flow chart of included studies, based on PRISMA guidelines.



Unique ID	Study ID	Randomization process	Deviations from intended interventions	Missing outcome data	Measurement of the outcome	Selection of the reported result	Overall		
Study 1	Arumughan et al., 2018	?	?	+	+	?	!	+	Low risk
Study 2	Lalnunpuii et al., 2020	+	+	+	+	+	+	?	Some concerns
Study 3	Dalaie et al., 2015	+	?	+	+	?	!	–	High risk
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	+	+	+	+	+	+

Figure 2A. Risk of bias assessment (RoB-2).

Figure 2B. Collective data for risk of bias, according to RoB-2 domains.

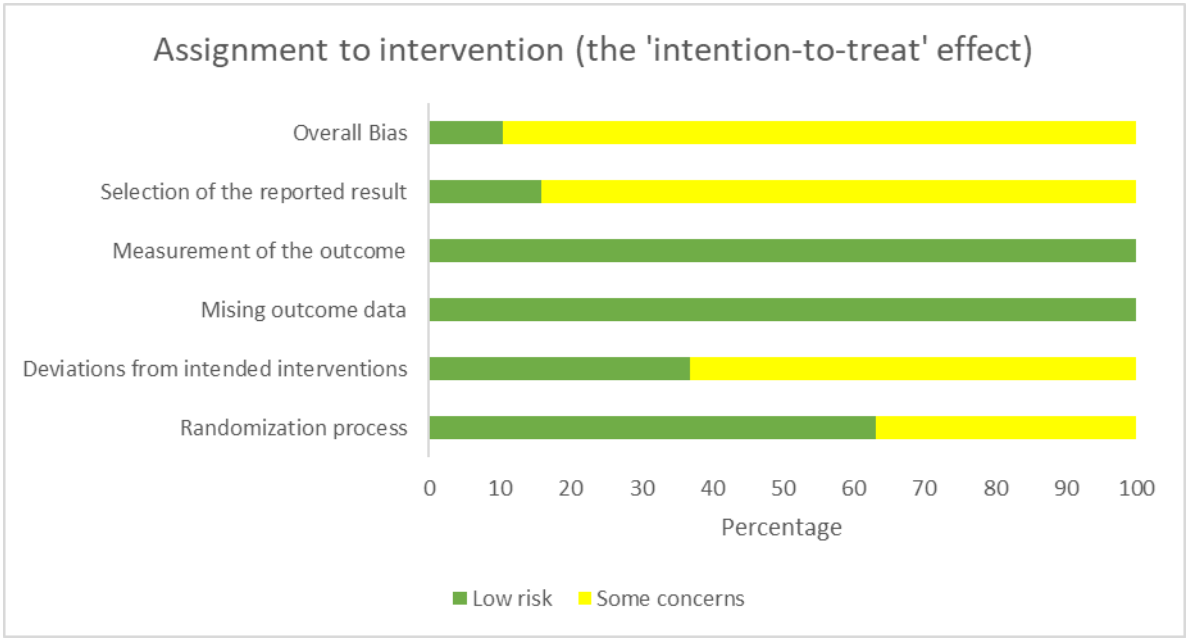
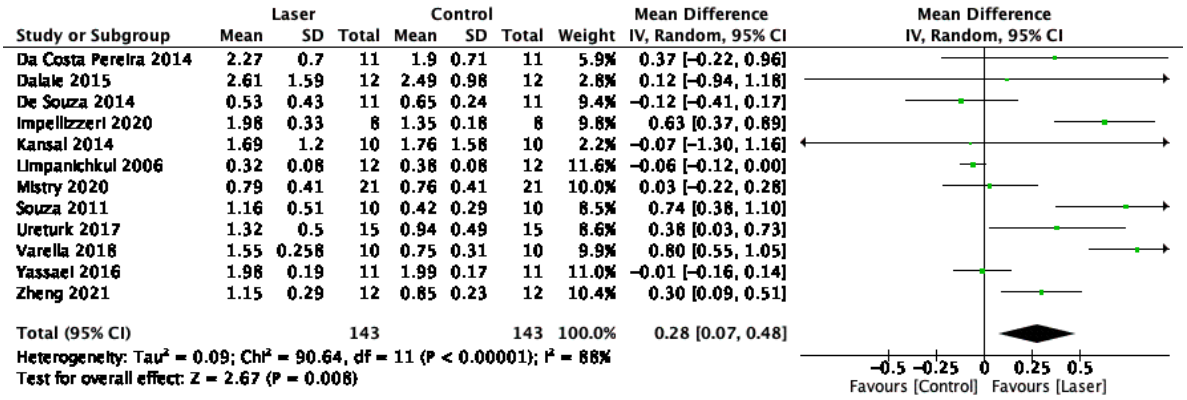
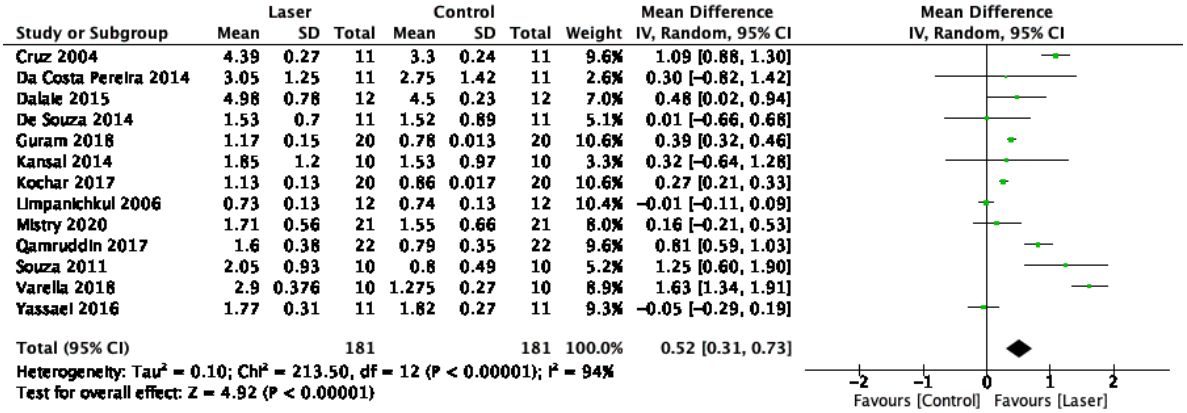


Figure 3A-D. Forest plot of the comparison between the LLLT and control groups at months 1,2,3 and 4 respectively. OR, odds ratio; CI, Confidence interval.

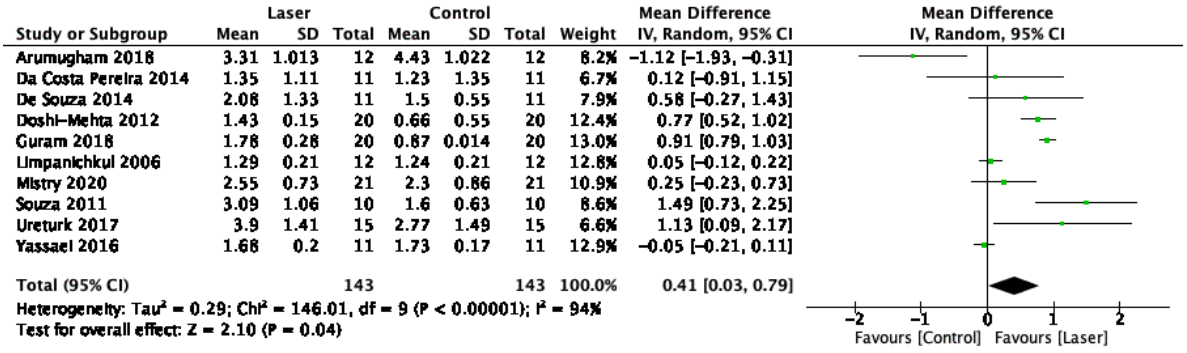
A



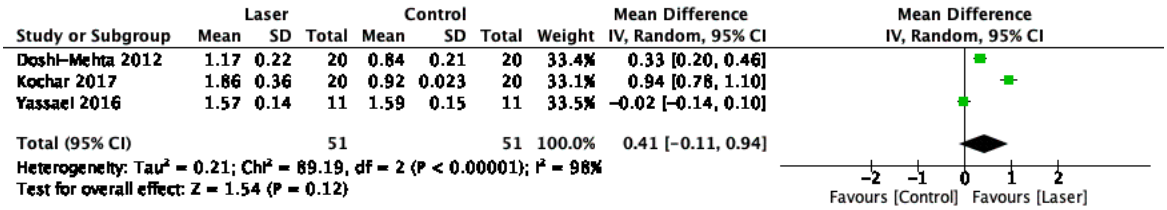
B



C



D


Laser
Control
Mean Difference
Mean Difference
Study or Subgroup Mean SD Total Mean SD Total Weight IV, Random, 95% CI
IV, Random, 95% CI
Doshi-Mehta 2012 1.17 0.22 20 0.84 0.21 20 33.4% 0.33 [0.20, 0.46]
Kochar 2017 1.86 0.36 20 0.92 0.023 20 33.1% 0.94 [0.78, 1.10]
Yassael 2016 1.57 0.14 11 1.59 0.15 11 33.5% −0.02 [−0.14, 0.10]
Total (95% CI) 51 51 100.0% 0.41 [−0.11, 0.94]
Heterogeneity: Tau² = 0.21; Chi² = 89.19, df = 2 (P < 0.00001); I² = 98%
Test for overall effect: Z = 1.54 (P = 0.12)
−2 −1 0 1 2
Favours [Control] Favours [Laser]