Photobiomodulation in Tooth Surgery

Subjects: Dentistry, Oral Surgery & Medicine

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The surgical extraction of the lower third molars is widely practiced in oral surgery. Subsequent inflammatory complications such as pain, facial swelling, and trismus can negatively affect the quality of life of the patients. Non-medication methods used to minimize tissue injury after third-molar extraction and without side effects include the use of photobiomodulation.

photobiomodulation laser low level laser therapy tooth extraction oral surgery pain swelling trismus

1. Introduction

The surgical extraction of the third mandibular molars is the most frequent procedure in oral and maxillo-facial surgery[1].

An impacted third molar can cause different consequences such as pericoronitis, distal caries and periodontal pocket of the second molar, odontogenic abscesses, and the development of follicular cysts[2].

The healing period following the surgical extraction of an impacted third mandibular molar is associated with an intense inflammatory response. This process is responsible for postoperative pain, facial swelling, and trismus, which negatively affect the quality of life of the patients during 7–10 days after the surgery[3]. These signs and symptoms are a consequence of the surgical wound and the duration of the surgery itself[4], as the result of a direct trauma on the blood and lymphatic vessels[5]. After local anesthesia wears off, the pain usually reaches maximum intensity 3 to 5 h after surgery, continuing for 2 to 3 days, and gradually diminishing until the seventh day[6][7]. Swelling reaches peak intensity in 12 to 48 h, influencing facial esthetics and social interactions. It usually resolves between the fifth and seventh days. Trismus may be considered initially as having a protective function by encouraging the patient to rest the surgical site and permit healing. However, it may lead to difficulty in eating and functioning if it persists for more than a few days.

Piezoelectric devices, which can be used instead of conventional burs, may be beneficial for surgeries at complex anatomical sites because they can preferentially cut mineralized structure[8]; furthermore, some authors reported a reduction in postoperative sequelae using the piezoelectric surgical technique in third molar extraction[9][10].

The standard therapeutic approach to reduce the postoperative complications is the administration of medications such as non-steroidal anti-inflammatories (FANS), corticosteroids (CS), and analgesics. However, even if they are

effective, these drugs present some important adverse effects such as the tendency to systemic bleeding, gastrointestinal irritation, and allergic reactions. In addition, antibiotics reduce the risk of postoperative infection and alveolitis, but the possibility of developing bacterial resistance makes their administration indicated only in selected cases[11].

These considerations justify the effort to find alternative and innovative methods for the resolution of the symptomatology that follows the surgical extraction of the impacted mandibular third molars, possibly without adverse effects. Non-medication methods used to minimize the postoperative after third molar extraction include cryotherapy, acupuncture, and photobiomodulation (PBM)[12][13][14].

PBM is the application of near-infrared (NIR) light for therapeutic purpose. The “optical window” in which the effective penetration of light into tissues is maximized is between approximately 600 and 1200 nm. Low-energy laser light produces photochemical effects whereby it penetrates the mucosa without overheating or producing other side effects[15].

In literature, the conclusions of the effectiveness of PBM after third molars surgical extractions are controversial. The current evidence on the effect of PBM on pain, swelling, and trismus after third molars surgery are summarized and reported.

2. Description of the Studies

A detailed flow chart of the selection process is shown in **Figure 1**.

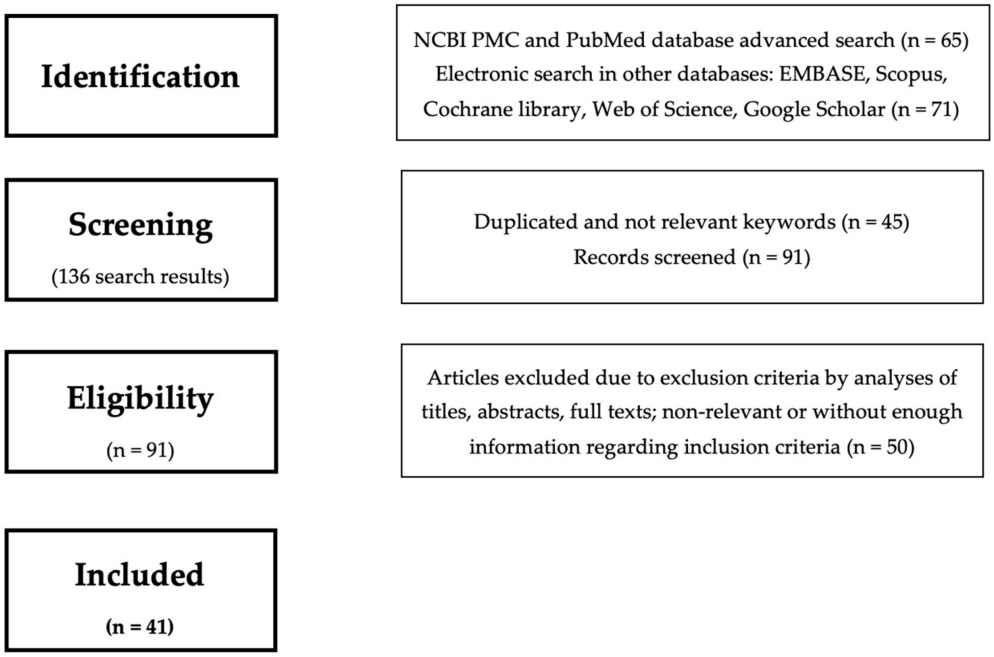

Figure 1. Flow chart illustrating the search strategy.

A total of 1833 subjects participated across the 41 studies. Nine studies did not record participants' gender; in the other studies, there were 727 female participants and 1106 male participants.

The characteristics of the included studies are presented in **Table 1** and **Table 2**.

Table 1. Characteristics of the included studies.

Authors and Year of Publication	Laser Properties			Outcomes	Sample Size
	(nm)	(mW)	(J/cm^2)		
Asutay et al. (2018)[16]	810	300	4	pain, trismus, swelling	45
Hamid et al. (2017)[17]	810	100	32, 86	pain	30
Landucci et al. (2016)[18]	780	10	7, 5	pain, trismus, swelling	22
Sierra et al. (2015)[19]	660, 808	100	106	pain	60
Sierra et al. (2016)[20]	660, 808	100	106	pain	60
Pol et al. (2016)[21]	650, 904	8–500, 70	no reported	pain, swelling	25
Abdel-Alim et al. (2015)[22]	830	4	no reported	pain, trismus, swelling	80
Fabre et al. (2015)[23]	660	35	5	pain, trismus, swelling	10
Merigo et al. (2015)[24]	650, 910	no reported	480, 31	pain, swelling	59
Ferrante et al. (2013)[25]	980	300	no reported	pain, trismus, swelling	30
Koparal et al. (2018)[26]	810	300	4	pain, trismus, swelling	45
Raisesian et al. (2017)[27]	980	300	18	pain, trismus, swelling	44
Petrini et al. (2017)[28]	980	300	no reported	pain, trismus, swelling	45
Kahraman et al. (2017)[29]	830	100	3	pain	53

Authors and Year of Publication	Laser Properties			Outcomes	Sample Size
	(nm)	(mW)	(J/cm^2)		
Alan et al. (2016)[30]	810	300	4	pain, trismus, swelling	15
Eroglu et al. (2016)[31]	940	no reported	4	pain, trismus, swelling	35
Eshghpour et al. (2016)[32]	660	200	85, 7	pain, swelling	40
Kazancioglu et al. (2014)[33]	808	100	4	pain, trismus, swelling	60
Tuk et al. (2017)[34]	660	198	67,5	pain	163
Farhadi et al. (2017)[35]	550	100	5	pain, trismus, swelling	48
Pedreira et al. (2016)[36]	808	no reported	2	pain, trismus, swelling	24
Lopez Ramirez et al. (2012)[37]	810	500	5	pain, trismus, swelling	20
Amarillas et al. (2010)[38]	810	c100	4	pain, trismus, swelling	30
Roynesdal et al. (1993)[39]	830	40	no reported	pain, trismus, swelling	25
Fernando et al. (1993)[40]	830	30	no reported	pain, swelling	52
Markovic et al. (2007)[41]	637	50	4	swelling	120
Aras et al. (2009)[42]	808	100	4	swelling, trismus	32
Aras et al. (2010)[43]	808	100	4	swelling, trismus	48
Feslihan et al. (2019)[44]	810	300	6	pain, trismus, swelling	30
Santos et al. (2020)[45]	780	70	52, 5	pain	32
Lakshmi et al. (2021)[46]	980	300	no reported	pain, trismus, swelling	100
El Saeed et al. (2020)[47]	980	500	4	pain, trismus, swelling	20

Authors and Year of Publication	Laser Properties			Outcomes	Sample Size
	(nm)	(mW)	(J/cm^2)		
Nejat et al. (2021)[48]	660, 980	200	1.5, 6	pain	80
Kamal et al. (2021)[49]	980	100	no reported	pain, trismus, swelling	24
Bianchi de Moraes et al. (2020)[50]	660	30	10, 30	pain, trismus, swelling	57
Kumar Gulia et al. (2021)[51]	940	500	10	pain, trismus, swelling	32

	Method of Evaluation	Comparison	Results		
			Pain	Swelling	Trismus
[16]	VAS, MO, 3dMD FP	vs. placebo	Reduction	Not statistically significant	Not statistically significant
[17]	VAS	vs. placebo	Reduction		
[18]	VAS, NRS	vs. placebo	Not statistically significant	Reduction	Reduction
[19]	VAS, FDM, MO	vs. placebo	Reduction		
[20]	FDM, MO	808 nm vs. 660 nm		808 Reduction	808 Reduction
[21]	VAS, FDM	vs. placebo	Reduction	Reduction	
[22]	MO, Bello's FSA	vs. delayed PBM	Reduction	Reduction	Reduction
[23]	VAS, FDM, MO	vs. placebo	Reduction	Reduction	Reduction
[24]	VAS, FDM	vs. placebo	Reduction	Reduction	
[25]	VAS, FDM, MO	vs. placebo	Reduction	Reduction	Reduction
[26]	VAS, MO, 3dMD FP	vs. placebo	Reduction	Not statistically significant	Not statistically significant
[27]	VAS, FDM, MO	vs. drug therapy	Reduction	Not statistically significant	Not statistically significant
[28]	VAS, FDM, MO	vs. drug therapy	Reduction	Reduction	Not statistically significant

	Method of Evaluation	Comparison	Results		
			Pain	Swelling	Trismus
[29]	VAS	intraoral vs. extraoral	Reduction		
[30]	VAS, MO, 3dMD FP	vs. placebo	Reduction	Not statistically significant	Not statistically significant
[31]	VAS, FDM, MO	vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[32]	VAS, ECE	vs. placebo	Reduction	Reduction	
[33]	VAS, FDM, MO	vs. ozone therapy	Reduction	Reduction	Reduction
[34]	HR, SR, Questionnaire	vs. placebo	Not statistically significant		
[35]	VAS, FDM, MO	vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[36]	VAS, FDM, MO	vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[37]	VAS, FDM, MO	vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[38]	VAS, FDM, MO	vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[39]	VAS, FS, MO	vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[40]	VAS, Swelling scale	vs. placebo	Not statistically significant	Not statistically significant	
[41]	FDM	vs. placebo		Reduction	
[42]	Amin Laskin FS, MO	vs. placebo		Reduction	Reduction
[43]	Amin Laskin FS, MO	intraoral vs. extraoral		Reduction	Reduction
[44]	VAS, FDM, MO	vs. methylprednisolone	Not statistically significant	Not statistically significant	Not statistically significant
[45]	VAS	vs. split mouth	Reduction		

	Method of Evaluation	Comparison	Results		
			Pain	Swelling	Trismus
[46]	VAS, FS, MO	vs. placebo	Not statistically significant	Reduction	Reduction
[47]	VAS, FS, MO	vs. placebo	Reduction	Reduction	Reduction
[48]	VAS	vs. placebo	Reduction		
[49]	VAS, FS, MO	vs placebo	Reduction	Reduction	Reduction
[50]	VAS, MO, 3dMD FP	10 J/cm^2 vs. 30 J/cm^2 vs. placebo	Not statistically significant	Not statistically significant	Not statistically significant
[51]	VAS, FS, MO	vs. placebo	Reduction	Not statistically significant	Not statistically significant
[52]	VAS, FS	vs. placebo	Reduction	Reduction	
[53]	VAS, FS, MO	vs. placebo	Reduction	Not statistically significant	Not statistically significant
[54]	VAS, FS, MO	vs. placebo	Reduction	Reduction	Not statistically significant
[55]	VAS, FS	LLLT + aPDT vs. placebo	Reduction	Not statistically significant	
[56]	VAS, FS, MO	vs. split mouth	Reduction	Reduction	Not statistically significant

[33][45][46][47][51][52][53][54][55][56] [16][17][19][21][22][23][24][25][26][27][28][29][30][32]

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densities (2–60 J/cm^2). The most successful wavelengths in reducing pain were 810 and 980 nm (**Figure 2**).

Legend: aPDT, a al swelling, MO, maximum mouth scale, 3dMD FP, 3dMD face photo

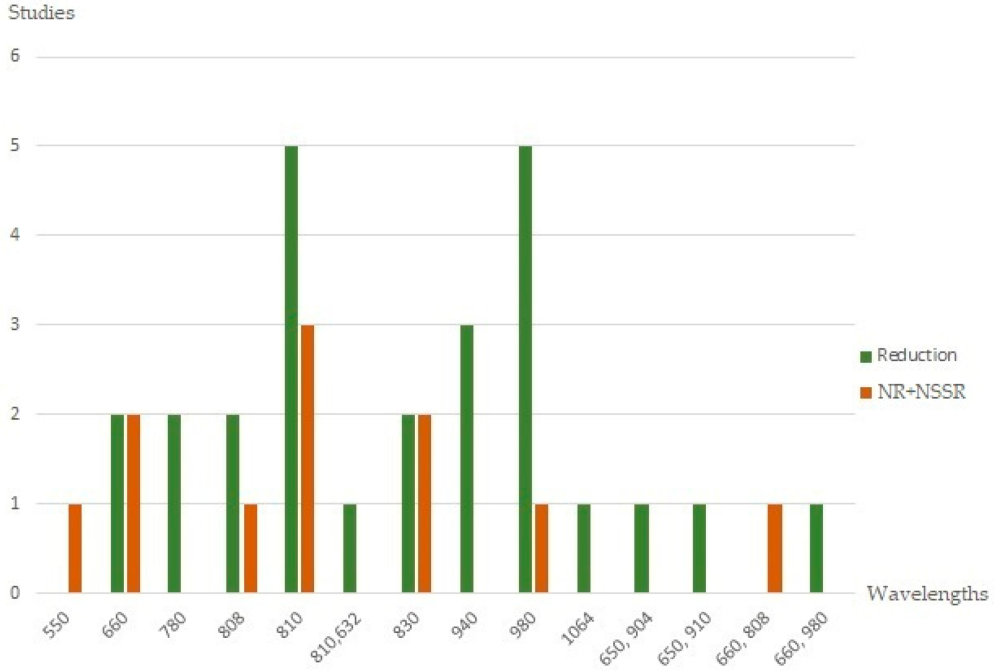

Figure 2. Histograms showing the pain outcome according to the wavelengths of the included studies. Legend: NR, no reduction, NSSR, no statistically significant results.

3.2. Facial Swelling

Facial swelling was assessed in 36 studies[16][18][21][22][23][24][25][26][27][28][35][36][37][38][39][40][41][42][44][46][49][50][51][52][53][54][55][56]. Nineteen articles reported significant decrease in facial swelling after PBM application when compared with placebo[18][20][21][22][23][24][25][32][33][41][42][43][46][47][49][52][54][56]. The laser's parameters of the included articles were as follows: wavelengths ranged from 650 to 1064 nm; powers were between 4 and 1000 mW; energy densities were between 2 and 480 J/cm^2. The wavelength of 810 nm induced the smallest facial swelling reduction (**Figure 3**).

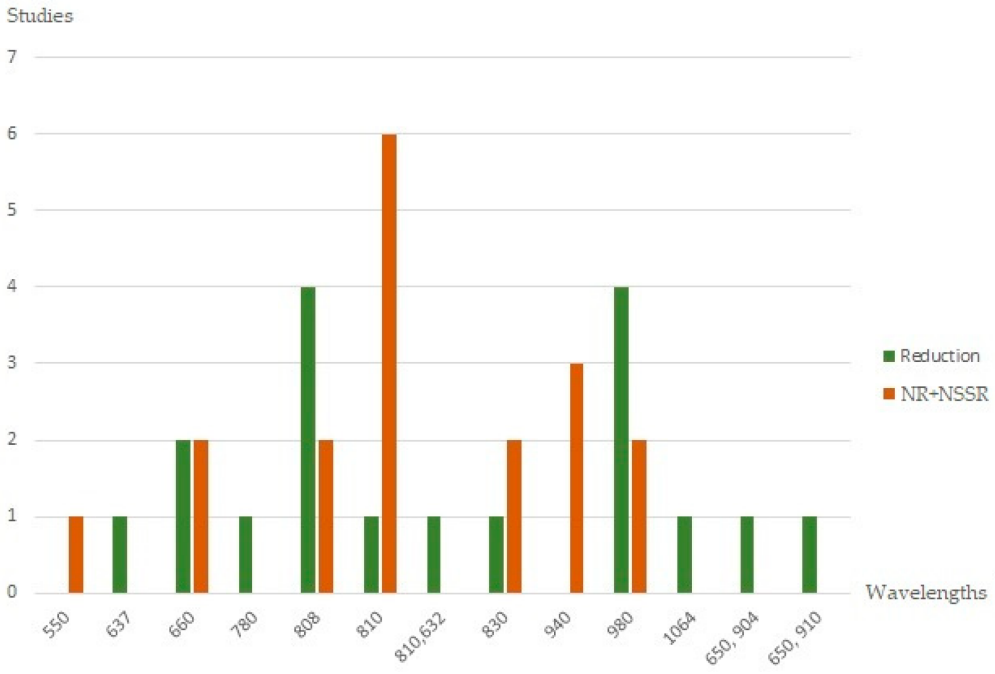

Figure 3. Histograms showing the swelling outcome according to the wavelengths of the included studies. Legend: NR, no reduction, NSSR, no statistically significant results.

3.3. Trismus

Twenty-eight studies assessed the impact of PBM on postoperative trismus. Eleven studies reported reducing of trismus with PBM[19][20][22][23][25][33][42][43][46][47][49]. In the included studies, wavelengths ranged between 660 and 980 nm, power ranged between 4 and 500 mW, and energy densities were between 4 and 212 J/cm^2. As for swelling, the wavelength of 810 nm was the one that induced the worst outcome. Instead, the wavelength of 980 nm determined the better reduction of trismus (**Figure 4**).

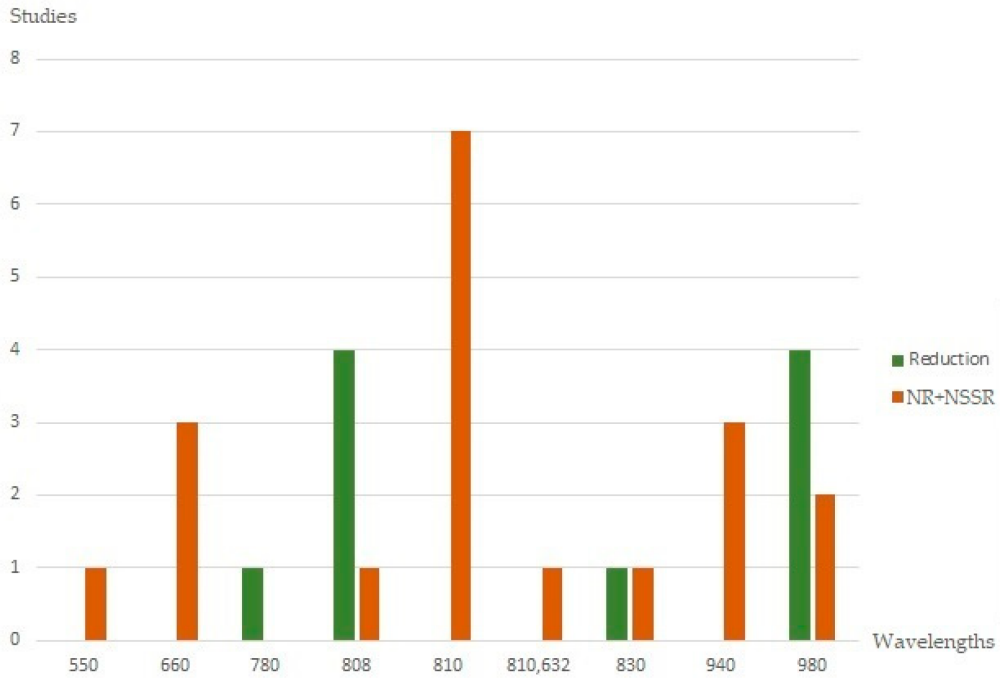

Figure 4. Histograms showing the trismus outcome according to the wavelengths of the included studies. Legend: NR, no reduction, NSSR, no statistically significant results.

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