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Review Article

REVIEW ARTICLE

Effects of Low-Level LASER Therapy on Temporomandibular Joint Dysfunction-Related Pain: A Systematic Literature Review

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Abstract

Purpose Low-Level LASER therapy (LLLT) is a non-pharmacologic medical device that purports to take advantage of photo biomodulation to induce cellular level biomechanical adaptations. Such mechanisms are sought by clinicians and patients to take advantage of reduced symptoms via faster healing times in cases like temporomandibular joint dysfunction (TMJD), where the joint affected is not easily accessible to traditional care. Systematic literature searches for randomized controlled trials between 2014 and 2024 were performed in PubMed, EBSCO, and Science Direct. A total of six randomized controlled trials (full text available, PEDro score 6, and conducted in the past ten years) met search criteria with a total of 363 subjects. Half the trials, with 36% of the total subjects, showed no difference between LLLT and the control or placebo. This review of current randomized controlled trials presented limited evidence for utilizing LLLT on patients with TMJD-related pain.

Key words: low-level laser therapy, pain, temporomandibular joint dysfunction

Introduction

During Operation Iraqi Freedom and Enduring Freedom, craniomaxillofacial injuries in conflicts in Afghanistan and Iraq accounted for 4783 of the trauma cases reported. These included soft tissue injuries and fractures.[1] Similarly, an extensive retrospective Turkish trauma study revealed that the mandible was the most affected area in the majority of head injuries. Blasts and gunshot wounds also account for the leading and second leading cause of craniomaxillofacial trauma to the skull in a case series from Misrata, Libya, conflicts between February and November 2011.[2] Rehabilitation professionals routinely encounter the long-lasting effects of traumatic temporomandibular joint damage (TMJD) during physical therapy and return to activities of daily living.

Low-level LASERS are modalities utilized across a spectrum of medical applications. LASER applications include vision correction, dermatological photorejuvenation, tumor destruction, lithotripsy, and minimally invasive surgery. In injury recovery, it is utilized for the reduction of inflammation, promotion of cellular activity, aiding in the healing process, and reduction of nociceptive symptoms.[3] The anatomical configuration makes therapeutic work on the temporomandibular joint a complicated proposition. The use of photo biomodulation, if found effective, reduces the need for complex procedures and therapies during care. This literature review looks at the state of the research in terms of LASER application for injuries and dysfunctions of the temporomandibular joint.

Temporomandibular Joint Anatomy and Dysfunction

Temporomandibular Joint Dysfunctions (TMJD) comprise a wide variety of disorders that affect the skull and the jaw. It is comprised of the squamous section of the temporal area of the skull where the glenoid fossa meets the condyle of the mandible. It is a complex diarthroidal joint further defined as a ginglymoarthroidal junction. Posteriorly it is marked by the styloid process of the skull, connected to the mandible by the stylomastoid ligament. Laterally, the synovial joint capsule is supported by the temporomandibular as well as the sphenomandibular ligaments. Anteriorly, the prominent structures are the conoid process as well as the ramus of the mandible.[4,5] The etiology of TMJD may be caused by the synovial joint and its alignment, the various ligaments supporting the joint, the muscles utilized in opening and closing the jaw, the muscles for mastication, degenerative processes, affectation of the auriculotemporal, masseteric, temporal, or mandibular nerve or a combination of these factors.[6]

Low-Level LASER Therapy and its Effects

Low-level LASER Therapy (LLLT) is a form of a non-pharmacological intervention commonly utilized in the management and treatment of musculoskeletal disorders along with various physical rehabilitation techniques such as exercise, joint manipulation, muscle retraining, neuromuscular reeducation, and therapeutic activities.[7] The purported mechanism by which LLLT affects musculoskeletal disorders is through the lowering of inflammatory biomarkers, increased ATP due to mitochondrial activity, activation of the reactive oxygen series, increased flow of neutrophil cells, and endorphin release.[8]

Endorphin release is the primary method by which the nociceptive response is blunted, and when combined with inflammatory biomarker reduction, it leads to decreased pain response. Increased ATP due to mitochondrial activity and activation of the reactive oxygen series facilitate healing and cellular growth and regeneration. Increased neutrophil flow is responsible for infection control and the immune system response.[9]

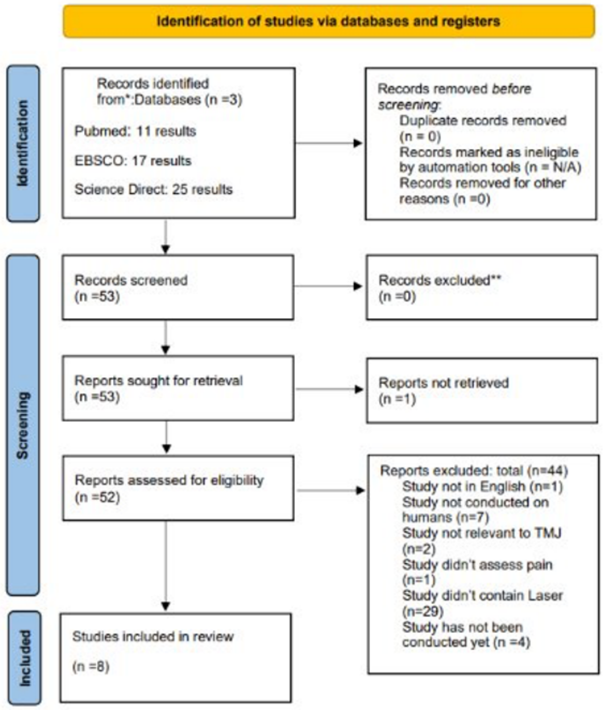
Photobiomodulation is another proposed mechanism by which low-level laser therapy provides plausibility of favorable biological effects.[10] The use of LASER light in lower wattage promotes not just wound healing and reduction of edema but prevents tissue necrosis and alleviates nerve-related pain as well. The hypothesis behind the nociceptive effects of LLLT lies in its ability to affect the signals transmitted through A-delta and C fibers.[11] Other theories include affectation of the precursor proteins needed in nociception, such as controlling the release of substance P and the activation of beta-endorphins.[12] Recent comparisons between High-Intensity LASER Therapy (HILT) and LLLT show no superiority of one modality over the other.[13] Additionally, the more prevalent accessibility, affordability, and safety profile of LLLT was the main reason for its selection in this study.

Methodology and Data Extraction

This study's objective was to perform a systematic literature review of existing studies reporting the effects of low-level laser therapy (LLLT) on temporomandibular joint dysfunction (TMJD). A literature and evidence search was performed on the databases of PubMed, EBSCO, and Science Direct between February 20, 2014 and March 5, 2024. Articles were screened to identify randomized controlled trials that were determined eligible for this literature review. Published and peer-reviewed documents with full online versions and PDF files were downloaded. One article was requested through an interlibrary loan, and upon receipt, its full file was downloaded. During the database search, all article titles were reviewed, and relevant titles were printed. The abstracts for titles were read by both authors (see Fig. 1). A total of six randomized controlled trials (full text available, PEDro score 6, and conducted in the past ten years) met search criteria with a total of 363 subjects.

The methodological quality of the studies was rated by author (CK) using the Physiotherapy Evidence Database (PEDro) Scale (see Table 1). The PEDro scale is a commonly utilized valid assessment of the methodological quality of clinical trials.[14] The identified PEDro ordinal scores were highly correlated with transformed PEDro interval scores (r = 0.99). The PEDro scale likewise categorizes the levels of blinding and accounts for concealed allocation, intention-to-treat, and attrition, providing a broader and more indiscriminate assessment of methodological quality in the analysis of interventions where double-blinding studies are often not possible due to the heterogeneity of the interventions.[15]

Fig. 1. PRISMA flowchart for identification of relevant studies via databases and registers



One author (RB) assessed the risk of bias in the studies that met inclusion criteria utilizing Cochrane's risk of bias tool (RoB) for randomized trials (August 2019 version). The RoB tool used signaling questions to collect data about features of the randomized controlled trials that may affect the risk of bias. The tool then utilizes the responses to generate a judgment about the studies biases for identified domains. To gather information about features of the trial that may be relevant to the risk of bias. An algorithm then uses the answers to these questions to generate a proposed judgment about the risk of bias for each domain. The domains included the randomization process utilized, deviations from the treatment or intervention, gaps in outcome data, methods of outcome measurement, and consistency of selected results. Studies included in the review met low or moderate risk of bias.

Inclusion and Exclusion Criteria

Of all included studies from the database search, only randomized controlled trials were reviewed. Research had to be graded good (6-8 points on the PEDro scale) to excellent (9-11 points on the PEDro scale) for inclusion in the review. RCT's graded fair (4-5 points) and below were excluded due to the lower methodological quality. Only studies conducted between 2014 and 2024 were

Table 1. List of authors, years of publication, PEDro scores, number of subjects, and results of included studies in chronological order

Author(s)	Date of publication	PEDro Score	Subjects (n)	LLLT effective in reducing pain	LLLT not effective in reducing pain	LLLT equally as effective as Control/Placebo
Sancakli et al.	2015	8	n=30	X (n=30)		
Aisaiti et el	2021	8	n=100			X (n=100)
Shousha et al.	2021	6	n=112	X (n=112)		
Dias WCFG DS et al.	2022	6	n=34			X (n=34)
Rady et al.	2022	8	n=27			X (n=27)
Al-Quisi et al.	2023	8	n=60	X (n=60)		
Totals:			n=363	3 (n=202)	0	3 (n=161)

included to incorporate the prevalent and more recent technological models and protocols of LLLT application. Cross-referencing applicable articles was performed to locate additional articles. Language was limited to articles originally written in English. Keywords used were low-level laser therapy, pain, and temporomandibular joint dysfunction.

Results

A total of 53 articles were screened, and eight studies with a total population of (n=363) were included. Due to the heterogeneity of equipment, frequency, and dosage of treatment prescriptions, no meta-analysis was conducted. A higher variety of treatment protocols causes result inconsistency, leading to less predictability of outcomes.[16] Of the eight studies that met the inclusion and exclusion criteria, two trials did not meet PEDro quality guidelines (scored five or less). Of the six studies that met the criteria, there were statistically significant improvements reported in LLLT reducing pain in TMJD in three of the studies (n=202). LLLT was equally effective as the control or the placebo in three of the studies (n=161). There were no studies that reported that LLLT was not effective in reducing pain in TMJD.

Discussion

The results suggest that the effects of LLLT for the management of pain in TMJD are inconclusive, and its efficacy is debatable. There is inconsistency in the findings among the studies that met the inclusion criteria. Likewise, there is no significant difference between studies that reveal significant improvements in the use of LLLT in reducing pain related to TMJD (3 studies, n=202) compared to no better effect as the control group or the placebo (3 studies, n=161). Studies with favorable results towards significant improvement of pain with or without improvement in physical function suffer from issues with heterogeneity of not just sample characteristics but a wide variety of LASER therapy dosing and prescription ranges as well.

The authors recommend that the utilization of LLLT for musculoskeletal disorders should adhere to World Association of Laser Therapy (WALT) guidelines (see Table 2).[17] Universal implementation of the recommendations should guide not just care in the rehabilitation sciences but also treatment protocols in experimental research. These guidelines consider not just the qualities of the anatomical site but also size, minimum total joules, and LASER classification.

Table 2. WALT Dose table 904nm for LLLT

Recommended treatment doses for Low Level Laser Therapy

Laser class 3B, 904 nm GaAs Lasers

(Peak pulse output >1 Watt, mean output >5 mW and power density > 5mW/cm2)

Irradiation times should range between 30 and 600 seconds

Diagnoses	Min. area/points	Min. total dose	
Carpal-tunnel	2-3	4	Minimum 2 Joules per point
Lateral epicondylitis	2-3	2	Maximum 100mW/cm2
Biceps humeri cap.long.	2-3	2	
Supraspinatus	2-3	4	Minimum 2 Joules per point
Infraspinatus	2-3	4	Minimum 2 Joules per point
Trochanter major	2-3	2	
Patellartendon	2-3	2	
Tract. Iliotibialis	2-3	2	Maximum 100mW/cm2
Achilles tendon	2-3	2	Maximum 100mW/cm2
Plantar fasciitis	2-3	4	Minimum 2 Joules per point
Arthritis	**Points or cm2**	**Joules 904nm**	
Finger PIP or MCP	1-2	1	
Wrist	2-3	2	
Humeroradial joint	2-3	2	
Elbow	2-3	2	
Glenohumeral joint	2-3	2	Minimum 1 Joules per point
Acromioclavicular	2-3	2	
Temporomandibular	2-3	2	
Cervical spine	4	4	Minimum 1 Joules per point
Lumbar spine	4	4	Minimum 1 Joules per point
Hip	2	4	Minimum 2 Joules per point
Knee anteromedial	4-6	4	Minmum 1 Joules per point
Ankle	2-4	2	

Daily treatment for 2 weeks or treatment every other day for 3-4 weeks is recommended
Irradiation should cover most of the pathological tissue in the tendon/synovia.

Start with energy dose in table, then reduce by 30% when inflammation is under control
Therapeutic dose windows typically range from +/- 50% of given values, and doses outside these windows are inappropriate and should not be considered as Low Level Laser Therapy.
Recommended doses are for white/caucasian skin types based on results from clinical trials or extrapolation of study results with similar pathology and ultrasonographic tissue measurements.

Suggestions for Future Research

In addition to improving research quality by consistent implementation of WALT guidelines, the authors recommend some suggestions for future research. The application of the prescription of 2 x 904 nm joules in future temporomandibular joint studies will allow randomized controlled trials to be meta-analyzed in systematic reviews. Consistent application of treatment protocols reduced variability and increased predictability in treatment outcomes, allowing for better data synthesis. Blinding can also be achieved within such trials as treatment parameters are easily shielded from experimental and control groups to further identify the efficacy of the WALT guidelines. Further applications in real-world situations include the experimental use of LLLT in areas where traumatic injuries are being rehabilitated, and individuals of specific age ranges are treated using the protocol.

Conclusion

The findings of this systematic review do not recommend LLLT in managing pain related to TMJD. Evidence averaging 7.33 points as determined by the PEDro scale (Good categorized evidence scored at 6 to 8 points) showed that half (3 studies, n=202) of the reviewed studies support LLLT significantly reducing pain in TMJD while the other half (3 studies, n=161) shows pain modulation effects no better than the control group or the placebo. Of the studies where LLLT significantly affects pain in TMJD, there was a wide variance in dosing and prescription. This study recommends that future randomized controlled trials consider recommended dosing as proposed by the World Association for Photo Biomodulation Therapy (WALT) to ensure homogeneity of protocols and universal technique and application of LLLT use.

In terms of evidence-informed TMJD pain-related care, the authors continue to advise the application of current clinical practice guidelines (CPG) in the management of TMJD pain. Hallmarks of evidence-informed care for TMJD pain include the use of jaw exercises, joint mobilization techniques, cognitive behavioral therapy, and related relaxation techniques. Within the CPG, LLLT and other therapies such as acupuncture, occlusal splints, cartilage supplementation with or without hyaluronic acid injection, electrical nerve stimulation, and botulinum toxin injection, should continue to belong within the conditional recommendation category.[18]

Competing Interests

No competing interest is declared.

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