RESEARCH PAPER

Effectiveness of Low-Level Laser on Pain and Quality of Sleep in Patients with Chronic Sinusitis

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ABSTRACT
BACKGROUND: Chronic sinusitis is a persistent inflammatory condition of the paranasal sinuses that negatively affects quality of life, often leading to facial pain, nasal congestion, and disturbed sleep. Conventional treatment approaches may not always provide long-term relief and are frequently associated with recurrence. Low-Level Laser Therapy (LLLT) has emerged as a non-invasive modality with anti-inflammatory and analgesic properties. **AIM:** To evaluate the effectiveness of Low-Level Laser Therapy in reducing pain and improving sleep quality in patients with chronic sinusitis. **METHODOLOGY:** An experimental pre-post interventional study was conducted on 50 participants aged between 18–42 years diagnosed with chronic sinusitis. Non-probability sampling was used. Pain was assessed using a pressure algometer, while sleep quality and quality of life were evaluated using the SNOT-22 questionnaire. LLLT was administered over the frontal and maxillary sinus regions three times per week for a duration of four weeks. Pre- and post-treatment values were recorded and analysed. **RESULTS:** The mean pain threshold significantly increased from 2.00 ± 0.26 to 3.12 ± 0.39 ($p < 0.001$), indicating a reduction in pain. The mean SNOT-22 score significantly decreased from 50.52 ± 4.47 to 33.24 ± 6.50 ($p < 0.001$), reflecting improvement in sleep quality and overall quality of life. **CONCLUSION:** Low-Level Laser Therapy is an effective and safe non-invasive intervention for managing chronic sinusitis. It significantly reduces pain and improves sleep quality, thereby enhancing overall patient well-being.
Keywords: Low-level LASER Therapy, sleep quality, pain threshold, SNOT22, noninvasive treatment
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INTRODUCTION

Chronic rhinosinusitis is a common inflammatory disorder of paranasal sinuses associated with significant morbidity, impaired sleep and reduced quality of life. It is caused by infection, allergy, or autoimmune conditions. It is most commonly viral in origin and usually resolves within 10 days. More than 24 million people are affected annually.[2] Recently, sinusitis has been recognized as a major cause of reduced quality of life, poor sleep, and work absenteeism. Sinuses are air-filled cavities located within certain skull bones that open into the lateral wall of the nasal cavity.[1]

The paranasal sinuses include the frontal, maxillary, ethmoidal, and sphenoidal sinuses. They reduce skull weight, humidify inspired air, and enhance voice resonance. At birth, the sinuses are absent or underdeveloped and enlarge rapidly between 6–7 years of age with facial growth and eruption of permanent teeth.[3] Rhinosinusitis is classified according to symptom duration into acute rhinosinusitis (ARS), lasting less than 4 weeks, and chronic rhinosinusitis (CRS), persisting for more than 12 weeks. ARS may further be categorized into viral rhinosinusitis (VRS) and acute bacterial rhinosinusitis (ABRS), which is important because antibiotics are ineffective in viral infections.[4]

The nose warms, humidifies, and filters inhaled air and contains olfactory receptors for smell. The nasal cavity and paranasal sinuses are lined by respiratory epithelium, allowing infections to spread between them. Untreated sinus infections may lead to severe complications such as meningitis, brain abscess, orbital infection, and cavernous sinus thrombosis. Effective mucociliary clearance and drainage pathways are essential for sinus health. [5]

Biofilms are associated with nearly 65% of bacterial infections, including CRS. *Staphylococcus aureus* is commonly isolated in CRS and can form biofilms and antibiotic resistance, making treatment difficult.[6]

CRS is commonly classified into CRS with nasal polyps and CRS without nasal polyps, considering factors such as allergy, immune dysfunction, and impaired mucociliary clearance.[7] Diagnosis requires both symptoms and objective findings such as endoscopy or CT imaging.[7] Common causative organisms include *S. aureus* (20%), anaerobes (3%), *S. pneumoniae* (4%), and mixed organisms (16%).[9]

CRS is characterized by two or more symptoms, including nasal obstruction or discharge, with facial pain/pressure and reduced smell, along with endoscopic or CT evidence of sinus inflammation. [10] The condition significantly affects sleep, concentration, productivity, emotional health, and overall quality of life, with a burden comparable to asthma and chronic obstructive pulmonary disease. [11,12]

Low-level laser therapy (LLLT) acts by delivering low-intensity light absorbed by mitochondrial chromophores, particularly cytochrome c oxidase, leading to increased ATP production, enhanced cellular metabolism, tissue repair, and reduced inflammation.[13] LLLT has been used for wound healing, pain relief, and inflammatory conditions due to its anti-inflammatory and immunomodulatory effects.[14,15] Photo biomodulation also improves blood circulation, modulates reactive oxygen species, and stimulates tissue healing.[16,17] The therapeutic effects of LLLT are dose-dependent and follow the Arndt–Schulz law, where optimal low doses stimulate cellular activity while excessive doses may suppress it.[20] Different wavelengths penetrate tissues to varying depths, making correct dosage and application parameters important for effectiveness.[21] LLLT enhances fibroblast proliferation, collagen synthesis, tissue repair, and pain reduction while improving local circulation. [22–24]

The Sinonasal Outcome Test-22 (SNOT-22) is a validated tool widely used to assess quality of life and treatment outcomes in CRS patients. [28] LLLT has shown promising anti-inflammatory effects comparable to non-steroidal anti-inflammatory drugs and has demonstrated improvement in SNOT-22 scores in chronic maxillary sinusitis patients, suggesting its potential as a safe and non-invasive adjunctive treatment modality. [29]

METHODOLOGY

An experimental pre-post interventional study was carried out at Physiotherapy LAB, D.Y. Patil Medical College Hospital and Research Institute, Kolhapur, following approval from the Institutional Ethics Committee of D.Y. Patil Education Society (Deemed to be University), Kolhapur. The study was conducted over a period of six months. Participants were selected using a non-probability sampling technique. Based on the calculated sample size requirement of 49 participants, a total of 50 individuals diagnosed with chronic sinusitis were recruited for the study.

Inclusion Criteria

Participants aged between 18 and 42 years, both male and female participants, Individuals clinically diagnosed with chronic sinusitis, Presence of tenderness over the frontal or maxillary sinus region, Reduced pressure pain threshold in the affected sinus area assessed using a pressure algometer, Participants willing to participate voluntarily and provide written informed consent

Exclusion Criteria

Participants with congenital mucociliary disorders such as primary ciliary dyskinesia, individuals with a history of nasal surgery or surgical procedures involving the paranasal sinuses, presence of neoplasia, fungal infections affecting the sinonasal region, patients diagnosed with nasal polyps, individuals with neurological or cognitive impairments, presence of skin allergies or dermatological conditions over the treatment area, and participants currently receiving medication for chronic sinusitis were excluded from the study.

PROCEDURE

The study protocol was approved by the Institutional Ethics Committee and Protocol Committee of D.Y. Patil Education Society (Deemed to be University), Kolhapur, D.Y. Patil College of Physiotherapy, Kolhapur. The study was conducted at the Physiotherapy Laboratory of Dr. D.Y. Patil College of Physiotherapy, Kadam wadi, Kolhapur, along with various physiotherapy and outpatient clinical setups from where participants were recruited.

Participants diagnosed with chronic sinusitis were screened according to the inclusion and exclusion criteria. The purpose and procedure of the study were explained to all participants prior to enrolment, and written informed consent was obtained from those willing to participate. Baseline demographic details including age, gender, BMI, and duration of symptoms were recorded before initiation of the intervention.

A total of 50 participants with chronic sinusitis were included in the study. Individuals were required to present with either two or more major symptoms or one major symptom along with at least two minor symptoms associated with chronic sinusitis. Participants had experienced symptoms

involving the frontal or maxillary sinus region for a minimum duration of three months.

Pain assessment was performed using a pressure algometer to evaluate the pressure pain threshold over the affected sinus region. The algometer was positioned perpendicular to the skin surface, and pressure was gradually increased until the participant reported the onset of pain or discomfort. The maximum pressure pain threshold tolerated by the participant was recorded in kg/cm².

Sleep quality and overall quality of life were assessed using the Sinonasal Outcome Test-22 (SNOT-22) questionnaire. Assessments were carried out at baseline, after two weeks, and at the end of four weeks. Participants who were unable to attend the final follow-up physically were assessed through telephonic communication.

Low-Level Laser Therapy (LLLT) was administered over the frontal and maxillary sinus regions. The laser probe was applied perpendicular to the skin using the contact method and maintained at an angle of approximately 15–30 degrees along the ala-tragus line. During the procedure, participants were positioned in supine lying and protective goggles were provided. Six treatment points were administered over each sinus region, with each point receiving 33 seconds of laser exposure, resulting in a total application time of 198 seconds per sinus region. Treatment sessions were conducted three times per week for four weeks.

Pre- and post-intervention outcome measures were recorded and analysed statistically to determine the effectiveness of Low-Level Laser Therapy on pain and sleep quality in patients with chronic sinusitis.

RESULT

The results of the present study were analyzed to determine the effectiveness of Low-Level Laser Therapy (LLLT) on pain and quality of sleep in patients with chronic sinusitis. A total of 50 participants were included in the study. The collected data were analyzed using descriptive and inferential statistics. The findings are presented under the following headings:

1. AGE DISTRIBUTION

The age distribution of the participants showed that individuals included in the study were within the age group of 18 to 42 years. The mean age of the participants was 27.12 ± 6.15 years, indicating that the majority of the subjects belonged to the young adult population.

The standard deviation reflects moderate variability in age among the participants, suggesting that although most individuals were clustered around the mean age, there was a reasonable spread across the selected age group. This indicates that chronic sinusitis is prevalent among young adults and can significantly affect their daily functioning and quality of life.

Overall, the age distribution suggests that the study sample represents a typical population commonly affected by chronic sinusitis.

	Minimum	Maximum	Mean	Std. Deviation
AGE	19.00	41.00	27.12	6.15

2. GENDER DISTRIBUTION

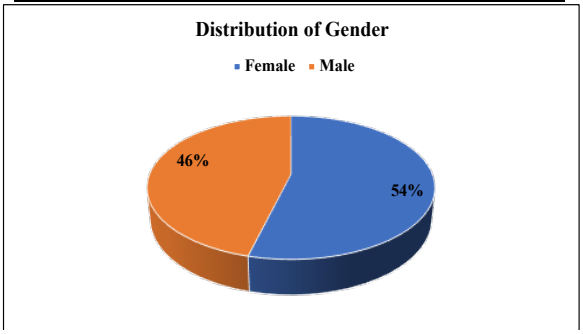
The gender distribution of the participants revealed that out of the total 50 subjects:

27 participants (54%) were females

23 participants (46%) were males

This indicates a slightly higher prevalence of chronic sinusitis among females compared to males in the present study. The difference, however, is not very large, suggesting that chronic sinusitis affects both genders almost equally. The graphical representation (pie chart) clearly shows the proportion of male and female participants included in the study.

Gender	Frequency	Percentage
Female	27	54%
Male	23	46%
Total	**50**	**100%**



3.COMPARISON OF PAIN USING PRESSURE ALGOMETER

Pain was assessed using a pressure algometer before and after the intervention. The pressure algometer measures the pressure pain threshold, which reflects the sensitivity of the affected area.

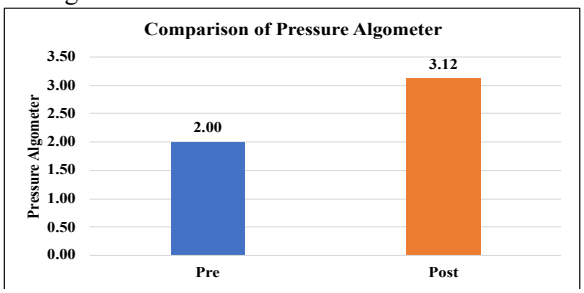
The mean pre-treatment value of pain threshold was 2.00 ± 0.26, whereas the mean post-treatment value increased to 3.12 ± 0.39.

The increase in the pressure pain threshold after the intervention indicates that the participants were able to tolerate more pressure, which reflects a reduction in pain sensitivity.

Statistical analysis using paired t-test showed that the difference between pre- and post-treatment values was highly significant ($p < 0.001$).

This significant improvement suggests that Low-Level Laser Therapy was effective in reducing pain in patients with chronic sinusitis.

The graphical representation (bar diagram) shows a clear increase in post-treatment values compared to pre-treatment values, supporting the statistical findings.



4. COMPARISON OF SNOT-22 SCORES (QUALITY OF SLEEP AND LIFE)

The SNOT-22 questionnaire was used to assess the quality of sleep and overall quality of life in patients with chronic sinusitis.

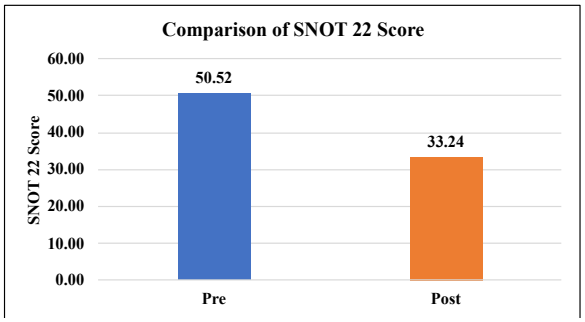
The mean pre-treatment SNOT-22 score was 50.52 ± 4.47, which decreased to 33.24 ± 6.50 after the intervention.

Since higher SNOT-22 scores indicate more severe symptoms and poorer quality of life, the reduction in scores demonstrates a significant improvement in symptoms, sleep quality, and daily functioning.

The difference between pre- and post-treatment scores was found to be statistically highly significant ($p < 0.001$).

This indicates that Low-Level Laser Therapy had a strong positive effect on improving the quality of life and sleep in patients with chronic sinusitis.

The graphical representation clearly shows a decrease in post-treatment scores compared to pre-treatment scores.



OVERALL ANALYSIS OF RESULTS

The overall analysis of the study demonstrates that there was a highly significant improvement in both outcome measures following the intervention.

Pain levels were significantly reduced as indicated by increased pressure pain threshold.

Sleep quality and quality of life improved significantly as shown by decreased SNOT-22 scores.

Both objective (pressure algometer) and subjective (SNOT-22 questionnaire) measures showed consistent improvement, which strengthens the validity of the findings.

Parameters	Assessment Period	Mean	Std. Deviation	p-value
PRESSURE ALGOMETER	Pre	2.00	0.20	<0.001*
	Post	3.12	0.39	
SNOT 22 SCORE	Pre	50.52	4.47	<0.001*
	Post	33.24	6.50	

STATISTICAL SIGNIFICANCE

The level of significance for the study was set at $p < 0.05$. However, the obtained p-values for both outcome measures were < 0.001, which indicates highly significant results.

This confirms that the improvements observed were not due to chance and were a result of the intervention.

Therefore:

Null Hypothesis (H_0) is rejected

Alternative Hypothesis (H_1) is accepted

DISCUSSION

The present investigation was carried out to assess the effectiveness of Low-Level Laser Therapy (LLLT) in alleviating pain and improving sleep quality in individuals with chronic sinusitis [1]. The results demonstrated a statistically highly significant improvement in both pain intensity and overall quality of life following the intervention [2]. These findings support the use of LLLT as an effective and non-invasive therapeutic modality in the management of chronic sinusitis [7]. Chronic sinusitis, also referred to

as chronic rhinosinusitis, is a persistent inflammatory condition involving the nasal cavity and paranasal sinuses, commonly presenting with nasal obstruction, facial pain, headache, and sleep disturbances [4]. These symptoms often persist for more than 12 weeks and significantly affect physical, emotional, and social well-being. Epidemiological evidence suggests that chronic rhinosinusitis affects approximately 5–12% of the population, contributing to a considerable socioeconomic burden due to healthcare costs and reduced productivity [6].

In the present study, the mean age of participants was 27.12 ± 6.15 years, indicating a higher prevalence among young adults, which is consistent with previous findings in the working-age population [2]. This highlights the negative impact of chronic sinusitis on occupational performance and daily functioning [3]. The gender distribution showed a slightly higher prevalence among females, which is in agreement with earlier epidemiological studies and may be attributed to hormonal, environmental, and behavioral factors [4].

Pain is one of the most significant and distressing symptoms associated with chronic sinusitis, primarily resulting from inflammation of the sinus mucosa and increased intra-sinus pressure [3]. In this study, pain was objectively measured using a pressure algometer, ensuring reliability and accuracy in assessment. A significant increase in pain threshold was observed following LLLT intervention, indicating reduced pain sensitivity [2]. This reduction in pain can be explained by the photo biomodulation effects of LLLT, which acts at the cellular level by stimulating mitochondrial chromophores such as cytochrome c oxidase. This stimulation enhances the electron transport chain, leading to increased production of adenosine triphosphate (ATP), which supports cellular metabolism and promotes tissue repair [13]. Additionally, LLLT reduces the production of inflammatory mediators such as TNF-α and prostaglandins, thereby exerting a strong anti-inflammatory effect [15]. It also modulates reactive oxygen species and intracellular signaling pathways, contributing to reduced cellular stress and improved healing [17].

Furthermore, LLLT improves local microcirculation, enhancing oxygen delivery and facilitating the removal of metabolic waste products, which accelerates tissue recovery and reduces pain perception [23]. These findings are supported by previous studies demonstrating the analgesic and anti-inflammatory effects of LLLT in various clinical conditions [14].

Sleep disturbance is another major concern in patients with chronic sinusitis due to persistent nasal obstruction and discomfort. Poor sleep quality further contributes to fatigue, reduced concentration, and decreased overall well-being [11]. In the present study, sleep quality was assessed using the SNOT-22 questionnaire, a validated tool for evaluating sinonasal symptoms and their impact on quality of life [28]. The results showed a significant reduction in SNOT-22 scores, indicating improvement in both sleep quality and overall health status [2]. This improvement can be attributed to the physiological effects of LLLT, which reduces mucosal edema and enhances mucociliary clearance, thereby facilitating effective sinus drainage and improving airflow [7]. Improved nasal patency allows better breathing during sleep, leading to enhanced sleep quality [11]. These findings are consistent with previous research that reports improvement in symptoms and quality of life following LLLT intervention in patients with rhinosinusitis [19]. Several studies have also demonstrated that LLLT promotes mucosal healing and reduces inflammation, further supporting its therapeutic effectiveness [26].

A major strength of the present study is the use of both objective and subjective outcome measures, which enhances the reliability of the findings. The pressure algometer provided objective data on pain, while the SNOT-22 questionnaire captured patient-reported outcomes related to sleep and quality of life. The consistency of improvement across both measures strengthens the validity of the results. Statistical analysis revealed highly significant results with a p-value less than 0.001, confirming that the observed improvements were due to the intervention. Based on these findings, the null hypothesis was rejected and the alternative hypothesis was accepted [2].

From a clinical perspective, LLLT offers several advantages, as it is non-invasive, painless, cost-effective, and associated with minimal side effects. It can be easily incorporated into physiotherapy practice as an adjunct to conventional treatment methods [24]. Despite these positive findings, certain limitations must be considered, including the small sample size, short duration of the study, and absence of a control group, which may limit the generalizability of the results [2].

Future research should focus on larger sample sizes, longer follow-up periods, and randomized controlled trials to provide stronger evidence for the effectiveness of LLLT [26]. Further studies are also required to determine optimal dosage parameters and explore combination therapies for improved clinical outcomes [21]. In conclusion, LLLT is an effective modality for reducing pain and improving sleep quality in patients with chronic sinusitis, acting through mechanisms such as reduction of inflammation, enhancement of cellular metabolism, and improvement of

microcirculation, thereby improving overall quality of life [17].

CONCLUSION

The findings of the present study clearly indicate that Low-Level Laser Therapy (LLLT) is highly effective in producing significant improvements in pain levels, sleep quality, and overall quality of life among patients with chronic sinusitis. The results obtained from the study showed statistically highly significant differences between pre- and post-intervention values ($p < 0.001$), confirming the effectiveness of the intervention. There was a marked increase in the pressure pain threshold as assessed by the pressure algometer, indicating a significant reduction in pain sensitivity following the treatment. Additionally, a considerable decrease in SNOT-22 scores was observed, reflecting improvement in nasal symptoms, sleep disturbances, and daily functional activities. These findings suggest that LLLT not only helps in reducing the physical symptoms associated with chronic sinusitis but also contributes to enhancing the overall well-being of the patients.

The therapeutic effects of Low-Level Laser Therapy can be attributed to its mechanism of photo biomodulation, which enhances cellular metabolism, reduces inflammation, and promotes tissue healing. The reduction in inflammatory mediators and improvement in local blood circulation play a crucial role in relieving pain and improving sinus function. As a result, patients experience better breathing, reduced discomfort, and improved sleep quality, which further enhances their daily performance and quality of life. The non-invasive nature, safety, and cost-effectiveness of LLLT make it a suitable and practical treatment option in clinical settings.

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