

## Effect of Laser Therapy in the Treatment of Chronic Rhino Sinusitis: A Review

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### Abstract

Chronic Rhino Sinusitis (CRS) is one of the most prevalent chronic illnesses affecting people of all ages. The various etiological causes and challenging diagnostic techniques have a role in misdiagnosis and severity of sinusitis. There is no typical sinusitis therapy. There are many new and developing treatments, both natural and developed, and staying up to date on these therapies and their effectiveness is still difficult. As new CRS treatment alternatives, low-level laser therapy and near-infrared laser therapy have generated some interest. According to certain research, these photo-therapies use various light wavelengths and intensities to decrease the production of biofilms and enhance the in vitro activity of antibiotics against sinus infections. On contrast to this, some studies concluded that phototherapy for CRS is still in its relative infancy and that better studies are required to accurately evaluate its therapeutic impact. The goal of this review was to gather data regarding how Laser therapy affected chronic sinusitis.

**Keywords:** Chronic Rhinosinusitis, Extra-oral Application, High Intensity Laser Therapy, Intra-oral Application, Low Level Laser Therapy.

### Introduction

Chronic rhinosinusitis (CRS) is an inflammatory condition of the paranasal sinuses and nose that has symptoms that last for at least 12 weeks without going away in spite of

receiving sufficient medical care. Because nasal inflammation usually often coexists with sinus mucosa inflammation, rhinosinusitis is now the word of choice. However, the terms sinusitis and rhinosinusitis are interchangeable [1, 2]. In spite of the terms rhinitis, sinusitis,

and rhinosinusitis suggest an inflammation of a type of tissue that is physically well-defined, these terms are now employed in a syndrome context. Symptoms include nasal blockage or stuffiness, pressure or pain in the face, anterior or posterior mucopurulent rhinorrhea, and hyposmia are used to identify rhinosinusitis (formerly known as sinusitis). Contrary to this definition, rhinitis is generally characterized by nasal blockage, sneezing, nasal irritation, and wet rhinorrhea. The term "sinusitis" has been replaced by "rhinosinusitis" in the present recommendations due to the fact that the nasal and sinus mucosa are one continuous tissue and that individuals with sinus inflammation frequently experience nasal symptoms [3]. Given that many sinus disorders exhibit a similar set of symptoms, CRS is frequently used as a general term for a wide range of sinus conditions. Furthermore, nasal endoscopy makes nasal tumors visible, and these individuals have higher total symptom scores, less facial discomfort, and more olfactory impairment and nasal blockage [4-7]. Sinusitis has a high incidence rate, affecting 14–16% of adult US citizens and has a significant negative impact on both health care costs and quality of life [8-10]. There is no conventional treatment for chronic sinusitis because the nature and genesis of this condition are not fully understood [11]. Symptoms of CRS are the same as those of acute rhinosinusitis [12]. When the main symptoms last for more than 12 weeks, are difficult to treat, or are resistant, symptoms continue even after receiving the recommended medical and surgical care, the condition is diagnosed as CRS. According to the type of inflammatory condition or endotype, recent research have concentrated on categorizing CRS as main or secondary [13]. Compared to those who suffer from chronic obstructive lung disease, congestive heart failure, and chronic low back pain, those with chronic sinusitis have a lower quality of life [14, 15]. Systemic antibiotics are not usually useful in treating infections caused by bacterial

biofilms, despite the fact that it has been demonstrated that they play a significant role in the etiology of chronic sinusitis [16, 17]. Corticosteroids and antibiotics are the main pharmacological therapy options. Oral and topical (inside the nose) corticosteroids are considered the first option for pharmaceutical therapy. The greatest evidence for the effectiveness of corticosteroids, which have extremely wide anti-inflammatory characteristics, is also available. In patients with chronic diseases like asthma, with high total steroid consumption as a result of the treatment of both intranasal and inhaled corticosteroids, precaution with topical intranasal corticosteroids is suggested, especially in children, pregnant females, and old age individuals. If the therapy doesn't work, there are surgical choices [18-20].

Drug interventions are not more effective than functional endoscopic operations in patients with no anatomical blockage. Due to these challenges in treating CRS, researchers and medical professionals proposed new treatment modalities as ultrasound therapy and laser therapy [13]. Therapeutic laser and ultrasonic treatments are preventing molecular interaction among bacteria, preventing the formation of bacterial biofilms, and dissolving existing bacterial biofilms [21, 22].

### **Therapeutic Efficacy of LASER Therapy on CRS**

Low-level laser therapy (LLLT) is a type of phototherapy that emits a coherent, low-power ( $\leq 500$  mw), single-wavelength beam of light [17]. Non-thermal phenomena are thought to be the cause of LLLT's photo biomodulation effect. It includes the production of nitric oxide (NO) and a rise in the levels of ATP as a result of the photon radiation being absorbed by chromophores such as cytochrome c oxidase within the mitochondria [23, 24]. These instances may result in normalized cell function, decreasing the inflammation, reducing pain and enhance healing of the

tissues in addition to modulating cellular metabolism. There is a significant data supporting the anti-inflammatory efficacy of LLLT utilized by physiotherapists [25–27]. It has been postulated that LLLT modulates biochemical inflammatory indicators [28]. LLLT alters the permeability of blood vessel, reduces blood rheology (coagulation of red blood cells), reduces edema, and causes a considerable reduction in the thickness of mucosal membrane in patients with CRS [25].

### **Therapeutic Efficacy of Intra-oral LLLT**

Sinus secretions accumulated in the maxilla's vestibule depth, which is actually the base of the maxillary sinus, due to gravity. As a result, this area really improved from the anti-inflammatory impact of laser utilizing the appropriate level of irradiation. However, the intra-oral laser therapy is unaffected by the thickness and color of the skin, the depth of the underlying muscles, and the connections of the zygomatic arch, which are significant in extra-oral irradiation in previous investigations [17, 22, 29, 30].

### **Application for Using Laser Therapy Extra-orally on Patients with Sinusitis**

#### **Extra-oral Application**

LLLT was applied on the skin above the cheekbones and forehead, for the maxillary and frontal sinuses, respectively. The laser beam was kept fixed and perpendicular to the skin (contact method) with an approximately 15–30 degree negative angle to the zygomatic arch along the ala–tragus line while the subjects were lying supine with wearing protective goggles. Each maxillary or frontal sinus had six points detected over it. Each point received 33 seconds of laser irradiation, for a total treatment time of 198 seconds, for each maxillary or frontal sinus. LLLT was utilized For 10 sessions, three times per week [17].

#### **Intra-oral Application**

Three neighbouring points at the maxillary vestibule depth, between the canine apical area and the initial molar apical area, which refers to the base of the maxillary sinus, were treated with pulsed laser with a duty cycle of 1:1 and 45 degrees using a probe laser [22, 43].

### **Extra-oral LLLT on CRS**

Afify et al, [31] conducted a study on 30 children (6-13 years) with CRS to compare the difference between LLL and pulsed electromagnetic field (PEMF) on the thickness of mucosal membrane by using CT examination. Both PEMF and LLLT were effective in improving mucosal membrane thickness in children with CRS, while there was no clear difference between LLLT and PEMF in the CRS' treatment, both LLLT and PEMF were successful in reducing mucosal membrane thickness in children suffering from CRS. These outcomes might be the result of infrared laser's deeper penetration than other therapeutic lasers that are frequently utilized.

According to a case study by Kijak et al [32] combining PEMF and light emitting diode (LED) Therapy for 30 daily sessions of 20minutes each significantly reduced sinus mucosa swelling to the point where even ethmoid bulla pneumatization was reduced. The sphenoid sinus' pathological abnormalities also disappeared entirely. The mucosal thickening was still apparent at the base of the maxillary sinuses. The greatest mucosal thickness in the right maxillary sinus was 3–4 mm. While in the left maxillary sinus ranged from 3 to 7 mm. The patient indicated that there had been a noticeable improvement, with the frontal headaches, pain in the eyes and nose, nasal blockage, and congestion all gone. These findings are based on PEMF and LED's ability to reduce swelling by enhancing regeneration, relieving pain, reducing inflammation and oedema, in addition to reducing bacteria, enhancing angiogenesis, and improving vasodilatation. There have been indications of improved tissue oxygen use, as well as positive

changes to the immunological and coagulation systems [33-38].

The effectiveness of extra-oral Ga-Al-As infrared diode laser on 15 patients with CRS was examined in a pilot study by Naghdi et al [17]. For 10 treatment sessions, the LLLT was used three times per week, with monthly phone follow-up for 18 months. Both the severity of each individual symptom and the Total symptom score (TSS) ratings considerably improved. This is because LLL has an anti-inflammatory action similar to dexamethasone on *Staphylococcus epidermidis*. Naghdi et al [39] conducted a single blinded controlled study on 14 adult with CRS with LLL extra-orally on 6 points on the cheek and forehead with 67 sec for each point for 5 sessions. There was improvement in the percentage TSS after LLL therapy. LLL can be used as an effective conservative modality for treatment of patients with CRS.

Isser et al [21] compared the effects of LLL with those of medications, sinuscopy, intranasal antrostomy, Antral Puncture-Wash (APW) and Caldwell Luc surgery. LLL was administered extra-orally either by "single- Probe" or "Cluster-Probe" one time daily for six days on alternate days. After the whole course of LASER was finished, the symptoms and indicators subsided. A study by Krespi and Kizhner [29] involved 23 patients with post-surgical CRS symptoms. They discovered that using a near infrared laser to treat CRS was both

objectively and subjectively advantageous, safe, repeatable, maintained, and seemed not to affect ciliary motility. Antibiotics or steroids were not used to prevent an aggravation of CRS.

In 12 rabbits with acute bacterial rhinosinusitis (ABRS), which was induced by filling the nose with a sponge soaked in a mixture including pathogenic microorganisms, Krespi et al. [40] examined the effects of near-infrared (NIR) laser therapy. Histological, radiological, and bacteriological tests all supported the diagnosis of ABRS. The packing was taken off and the nasal passages were laser-irradiated two days following the bacterial injection. In an animal model of ABRS, photograph-activated (PAD) bacteria and a single 940 NIR laser treatment resulted in an efficient microbial decrease. Bacterial death rates can reach 99.9%. Using conventional NIR diode optical energy, it is possible to thermally eliminate bacteria without harming the biological host site from irreversible heat-induced damage. Naghdi et al [41] assessed the impact of LLLT in 14 adult patients with CRS. Patients underwent five consecutive sham laser sessions followed by five consecutive actual laser sessions two days later. A laser was externally administered. Each sinus received a 33-second laser beam over each individual point. According to this study, five sessions of active LLLT were more effective at treating CRS symptoms than sham treatments (Table 1).

**Table 1.** Extra-oral LASER Studies Involving Rhinosinusitis.

Author	Target	Aim	Parameters	Outcomes	Results
[31]	Children with CRS.	To assess the effects of PEMF and extra-oral LLLT on the thickening of the mucosal membrane.	Ga-As (infrared red) laser ( $\lambda = 905$ nm, 9.12 Hz, 1.5 J for 8 minutes) PEMF (20 gauss, 7 Hz for 10 min).	CT scanning	Both the LLL and PEMF are effective in decreasing the symptoms of CRS

[32]	39-year-old female with paranasal sinusitis	To analyze the combining effect of EMF and LEDs	Two panel applicators of the VIOFOR JPS LED ( $\lambda= 630$ nm, 500 mW) Infrared light ( $\lambda= 855$ nm, 3400 mW), with light frequency of 181.8 Hz. EMF (magnetic flux density of 15 $\mu$ T and frequency of 180–195 Hz )	Cone beam computed tomography (CBCT)	In all paranasal sinuses, CBCT scans showed a significant decline in inflammation, and increased patient comfort
[17]	Adults with CRS	To assess the impact of extra-oral LLLT in CRS patients.	Ga-Al-As laser, Continuous mode ( $\lambda=830$ -nm, 30 mW , 1 J)	severity of individual symptoms and TSS	Improvement of symptoms with LLLT
[39]	Adults with CRS	To detect the effect of extra-oral LLLT in patients with CRS	Ga-Al-As laser, Continuous mode ( $\lambda=830$ -nm, 30 mW , 2 J)	severity of individual symptoms and TSS	LLL can be used as an effective conservative modality for treatment of patients with CRS
[21]	Adults with acute sinusitis and CRS	To evaluate the efficacy of extra-oral LLL in patients with CRS	Ga-Al-As laser, Continuous mode ( $\lambda=830$ -nm, 0.4 W/cm <sup>2</sup> )	Resolution of symptoms and sinus skiagrams	LLT is an effective, non-invasive technique of treatment
[29]	Adults post-surgical CRS	To investigate the effect of extra-oral LLL on patients with CRS.	Near-infrared (NIR) laser ( $\lambda=940$ nm)	Nasal endoscopic scoring (NES) SNOT20 scores, and cultures.	LLL was beneficial in managing CRS.

[40]	Rabbits with acute bacterial rhinosinusitis.	To evaluate the effects of extra-oral lasers on bacterial load and host.	Near infrared (NIR) 940nm, 1-3 W diode laser in the 1 <sup>st</sup> group. A photosensitizer and 635-nm laser in the 2 <sup>nd</sup> group.	Nasal cultures	Both NIR laser and photograph activated therapies significantly reduced the amount of bacteria.
[41]	Adults with CRS	To analyze the impact of extra-oral LLLT in patients with CRS	Ga-Al-As laser, Continuous mode ( $\lambda=830$ nm, 30 mW, 1 J)	TSS	LLLT was effective in the treatment of CRS symptoms.

### Intra-oral LLLT on CRS

The impact of high intensity laser therapy (HILT) intraorally on 34 patients with CRS was examined by Elkalla et al [42]. The intraoral diode laser was applied 3 sessions/ week for 12 weeks. With no negative side effects, intraoral treatment greatly reduced the signs and symptoms of sinus inflammation.

The efficacy of intra-oral LLL on 20 Adult patients suffering from CRS was studied by Mortazavi et al [22]. In eight sessions, the procedure was applied for 40 minutes (60

seconds to cover all 20 points on both facial sides in addition to recovery time). In addition to a dramatic reduction in disease-related symptoms, psychological issues also got much better. The last items on the Sino nasal outcome test 22 (SNOT22) questionnaire were sense of taste and smell and nasal blockage or congestion, which were two of the most significant symptoms. This is brought on by effect of LLL to reduce inflammation and bacteria, which are similar to those of NSAIDs (Table 1).

**Table 2.** Intra-oral LASER Studies Involving Rhinosinusitis

Author	Target	Aim	Parameters	Outcomes	Results
[42]	Adults with CRS.	To evaluate the effect of HILT on patients with CRS.	Pulsed diode ( $\lambda=810$ and 980 nm, 1W/cm <sup>2</sup> , 50 J/cm <sup>2</sup> for each point, 3 minutes/ sinus).	SNOT-22 and CT scanning.	Intraoral diode laser therapy is effective as a complementary treatment for CRS.

[22]	Adults with CRS.	To assess the effect of intra-oral LLL in patients with CRS.	low-level diode laser( $\lambda=810$ -nm, 0.1, 0.4, 0.3, 0.2 w, 4-7 J)	SNOT-22 and rhinomanometry	Intra-oral LLL is a suitable way to treat patients with CRS.
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### Comparing Intra-oral and Extra-oral LASER on CRS

On 40 patients with CRS, Mortazavi et al. [43] examined the effects of intra-oral and extra-oral LLL. Every other day for eight sessions, irradiation was carried out for 40

minutes every session, including recovery. Along with a statistically significant rise in total airflow and a significant decrease in nasal resistance, there was a clear improvement in clinical symptoms. Of the two forms of radiation, intra-oral radiation had a greater impact.

**Table 3.** Comparing Intra-oral and Extra-oral LASER Studies Involving Rhinosinusitis

Author	Target	Aim	Parameters	Outcomes	Results
[43]	Adults with CRS.	To compare the effect of intra-oral and extra-oral LLL in patients with CRS.	low-level diode laser( $\lambda=810$ -nm, 0.1, 0.4, 0.3, 0.2 w, 4-7 J)	SNOT-22 and rhinomanometry	Intra and extra-oral LLL are effective modalities in relieving the symptoms of CRS.

Laser therapy can be used in the treatment of CRS, more clinical trials are needed to investigate the effect of intra-oral application of different types of Laser therapy and also to compare the intra-oral and extra-oral application. In addition, different parameters of different types of laser therapy should be studied to identify the most powerful pattern of application (Table 3).

### Conclusion

Different types of Laser therapy including LLL, Ga-Al-As infrared diode laser, near infrared Laser, low level diode Laser and HILT can be used as a treatment modality for CRS either extra-orally or intra-orally. However,

future studies are required to detect the most effective type, parameters, and technique. Furthermore, comparison of the effectiveness of Laser therapy with other therapeutic modalities are recommended.

### Conflict of Interest

The authors declared no potential conflicts of interest with respect to the research, authorship and/or publication of this article.

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