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Comparative Study of Therapeutic Ultrasound Vs Low Level Laser Therapy Combined with Manual Drainage Technique on Subjects with Chronic Maxillary Rhinosinusitis

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ABSTRACT:

Introduction: Chronic maxillary rhinosinusitis is a persistent inflammatory disorder characterized by impaired sinus ventilation, pain, and reduced quality of life.

Conventional medical management may be limited due to poor sinus drainage and biofilm formation. Non-invasive physical therapy modalities such as therapeutic ultrasound and low-level laser therapy have demonstrated potential benefits, particularly when combined with manual drainage techniques. However, comparative evidence regarding their clinical effectiveness remains limited.

Materials and Methods: An informal experimental study was conducted at the Department of ENT OPD, SVIMS-COP. Thirty individuals diagnosed with chronic maxillary rhinosinusitis were randomly allocated into two groups. Group 1 received therapeutic ultrasound, while Group 2 received low-level laser therapy. Both groups

underwent ten treatment sessions on alternate days and received manual drainage as a common intervention. Outcome measures included pain intensity assessed using the Numerical Pain Rating Scale, chest expansion during nasal breathing, and quality of life evaluated using the Sino-Nasal Outcome Test-22. Assessments were performed before and after the intervention period.

Results: Both treatments led to reductions in pain, improvements in sinus symptoms, and increased chest expansion. Overall, ultrasound therapy produced more consistent and greater benefits, while both interventions were equally effective at the xiphoid level during inhalation

Conclusion: Both interventions are effective for symptom relief and improving chest expansion; however, Ultrasound Therapy appears to be superior overall compared to LLLT, making it a more effective treatment option in most measured outcomes.

Keywords : Paranasal Sinus Diseases; Physical Therapy Modalities; Quality of Life; Pain Measurement; Respiration

Introduction

Chronic rhinosinusitis is a long-standing inflammatory condition affecting the lining of the nasal passages and paranasal sinuses and is reported to affect approximately 10% of individuals in Western populations..[1,2] According to a report published by the *Times of India*, nearly 134 million individuals in India are affected by sinusitis. The high prevalence of this condition among adults contributes substantially to rising
healthcare expenditures and places significant strain on healthcare systems. Ongoing pain and discomfort associated with sinusitis often prompt patients to seek complementary or adjunctive therapeutic interventions.[3] Sinusitis is commonly classified into four stages based on symptom duration: the acute stage lasting approximately 2–4 weeks, the subacute stage persisting for 4–8 weeks, the chronic
stage continuing for 8–12 weeks or longer, and recurrent sinusitis, defined by episodes occurring more than three times in a year. [4]

The symptoms of rhinosinusitis, formerly known as sinusitis, include nasal obstruction, facial pressure or pain, anterior or posterior mucopurulent nasal discharge, and diminished smell. On the other hand, sneezing, watery nasal discharge, nasal discomfort, and congestion are commonly linked to rhinitis. Chronic rhinosinusitis is diagnosed when these main symptoms last more than 12 weeks, are challenging to treat, or persist even after receiving the proper medical and surgical care. (CRS) (5)

Pharmacological therapy, which includes antibiotics, decongestants, nasal sprays, corticosteroids, and antihistamines to reduce inflammation and dry out extra mucus, is the main initial treatment for sinusitis. Surgical techniques including balloon sinuplasty, functional endoscopic sinus surgery, drainage tube implantation, or other invasive surgical procedures may be taken into consideration in severe or recurrent instances that do not improve with medicinal treatment. [6,7] For the treatment of sinusitis, physical therapy offers a variety of therapeutic approaches. These include kinesio taping, nebulization, cervical muscle stretching, dry needling, electrotherapy modalities, manual drainage techniques, suboccipital release for sinus-related headaches, and rhinoflow therapy..[8] Ultrasound is one of the most commonly utilized physiotherapy modalities in the management of sinusitis.[9]

Low-level laser therapy (LLLT) possesses distinct laser light characteristics that differentiate it from other forms of light, including monochromaticity, collimation, and coherence. LLLT devices commonly utilize helium–neon (HeNe) or gallium–aluminum–arsenide (Ga-Al-As or Ga-As) sources to generate therapeutic laser light..[10] Although both ultrasound therapy (UST) and low-level laser therapy (LLLT) have demonstrated benefits in reducing inflammation, improving sinus drainage, and enhancing tissue repair in rhinosinusitis, limited research directly compares their effectiveness. This study addresses this gap by evaluating and contrasting UST and LLLT, thereby providing evidence to guide clinicians in selecting the most effective intervention for chronic maxillary rhinosinusitis.

Objectives-To assess the effect of ultrasound therapy on pain intensity by Numerical pain rating scale (NPRS), quality of life by Sino Nasal Outcome Test (SNOT-22), and chest expansion by Inch tape in patients with chronic maxillary rhinosinusitis.To
assess the effect of low-level laser therapy (LLLT) on pain intensity (NPRS), quality of life (SNOT-22), and chest expansion in patients with chronic maxillary rhinosinusitis.To compare the overall effectiveness of ultrasound therapy and LLLT, each combined with manual drainage on pain, chest expansion, and quality of life.

MATERIALS AND METHODS

Study method:

The study was conducted at SVIMS Hospital, Tirupati, using an informal experimental design (pre- and post-test without a control group). A simple random sampling method was employed to select a sample size of 30 participants, including both males and females. The duration of the study was six months.

Subjects who were clinically diagnosed by ENT surgeon with chronic sinusitis with a history of 3 months or longer,age group from 18 to 50 years of both males and females, presence of either two or more major symptoms, or one major plus two minor symptoms of sinusitis according to the task force diagnosis were included in the study. (11)

Table 1 - task force diagnosis

Major factors	Minor factors
Facial pain/pressure	Headache
Nasal obstruction/blockage	Fever
Nasal discharge/purulence/ discolored postnasal drainage	Halitosis
Hyposmia/anosmia	Fatigue
Purulence in nasal cavity on examination	Dental pain
	Cough
	Ear pain/pressure/fullness

*Enumerates the major & minor factors for diagnosis of sinusitis

Subjects who were done with sinus surgery, nasal septum deviation, and nasal polyp, Any metal implants (pacemakers, dental implants, or any other implants),history of any space-occupying lesions or malignancy, subjects with history of low blood
pressure and dizziness and suffering from any systemic illness, any history of neurological or cognitive deficit were excluded in the study(9)

Ethical approval:

The study was conducted after obtaining approval from the Institutional Ethics Committee (IEC no-1825). Subjects who met the inclusion criteria were explained the procedure, and after obtaining informed consent, they were included. Baseline assessments of pain intensity, chest expansion, and quality of life (QOL) were recorded. A total of 30 subjects were randomized into two experimental groups (15 in each) using the lottery method.

Study procedure:

Both groups received a common intervention of manual drainage technique for the maxillary sinus, performed by applying thumb pressure over the maxillary region and moving inferiorly below the ears, repeated seven times. (9)

Group 1 received therapeutic ultrasound therapy (Techno Med Electronics, Electroson-608) in supine lying, with the therapist positioned at the head end.

Ultrasound was delivered in continuous mode at an intensity of 1 W/cm² and frequency of 1 MHz, applied over the cheeks (maxillary sinus) using circular motion with a coupling gel, for 5 minutes per session, three times a week, for 10 alternate-day sessions(11) .

Group 2 received low-level laser therapy (Technomed Electronics, TECHLASER SS-1000) using a Ga-Al-As diode laser of 808 nm wavelength, 30 mW average power, and 6.7 J/point energy dose. The

laser was applied in contact technique over six points on each maxillary sinus with irradiation of 33 seconds per point (total 198 seconds per sinus), while the patient wore protective goggles. [10] Treatment was given three times a week for 10 alternate-day sessions. After completion, post-test assessments of pain intensity, chest expansion, and QOL were recorded.

Outcome measures

Pain intensity measured by NPRS scale , Chest expansion measured by Inch tape, QOL assessed by SNOT-22 Questionnaire

Results -

The data collected and tabulated in a excel sheet and analysed using SPSS version 23 and all the continuous data are presented as mean and SD.Shapiro wilk test was used to test the normality of the data, a paired t-test was used to analyse the pre and post values.

NPRS_PRE : Numerical pain rating scale pre test, NPRS_POST: Numerical pain rating scale post test, SNOT22_PRE: sino nasal outcome test 22 pre test,SNOT22_POST: sino nasal outcome test 22 post test ,INSP_2ndICS_PRE: Pre test inspiration at 2nd intercoastal space,INSP_2ndICS_POST: Post test inspiration at 2nd intercoastal space ,INSP_4thICS_PRE: Pre Test inspiration at 4th intercoastal space.INSP_4thICS_POST: Post test inspiration at 4th intercoastal space, INSP_XP_PRE: Pre test inspiration at Xiphoid process level, INSP_XP_POST: Post test inspiration at Xiphoid process level,EXPI_2ndICS_PRE: Pre test Expiration at 2nd intercoastal space, EXPI_4thICS_PRE:Pre test Expiration at 4th intercoastal space,EXPIR_XP_PRE : Pre test Expiration at Xiphoid process level,EXPI_2ndICS_POST: Post test Expiration at 2nd intercoastal space, EXPI_4thICS_POST:Post test Expiration at 4th intercoastal space,EXPI_XP_POST : Post test Expiration at Xiphoid process level

Table 2 - Descriptive Statistics: Group A and Group B

Variable	Mean of group A	Mean of group B
Age	28.8	22.4
NPRS_PRE	6.73	7.27
NPRS_POST	3.4	3.87
SNOT22_PRE	66.53	65.13
SNOT22_POST	26	20.87
INSP_2ndICS_PRE	34.82	30.81
INSP_4thICS_PRE	35.44	32.02
INSP_XP_PRE	33.41	31.69
EXPI_2ndICS_PRE	34.02	29.27
EXPI_4thICS_PRE	33.98	30.69
EXPIR_XP_PRE	32.07	30.18
INSP_2ndICS_POST	35.81	31.97
INSP_4thICS_POST	36.65	32.35
INSP_XP_POST	34.61	32.57
EXPI_2ndICS_POST	35.21	31.33

EXPI_4thICS_POST	35.11	32.17
EXPI_XP_POST	33.11	31.65

The table depicts Group A (Ultrasound Therapy), participants (mean age 28.8 years) showed a marked reduction in pain, significant improvement in QOL (SNOT-22), and increased chest expansion. In Group B (LLLT), younger participants (mean age 22.4 years) also demonstrated pain reduction, greater improvement in QOL, and enhanced chest expansion. Both interventions were effective in reducing symptoms and improving respiratory function.

Intra-Group analysis:

Table 3 : INTRAGROUP ANALYSIS Paired Samples Statistics - Group A and Group B

Pair	Outcome Measure	Mean of GROUP A	Mean of GROUP B
Pair 1	NPRS_PRE	6.73	7.27
	NPRS_POST	3.4	3.87
Pair 2	SNOT22_PRE	66.53	65.13
	SNOT22_POST	26	20.87
Pair 3	INSP_2ndICS_PRE	34.82	30.81
	INSP_2ndICS_POST	35.81	31.97
Pair 4	INSP_4thICS_PRE	35.44	32.02

	INSPI_4thICS_POST	36.65	32.35
Pair 5	INSP_XP_PRE	33.41	31.69
	INSP_XP_POST	34.61	32.57
Pair 6	EXPI_2ndICS_PRE	34.02	29.27
	EXPI_2ndICS_POST	35.21	31.33
Pair 7	EXPI_4thICS_PRE	33.98	30.69
	EXPI_4thICS_POST	35.11	32.17
Pair 8	EXPI_XP_PRE	32.07	30.18
	EXPI_XP_POST	33.11	31.65

The table depicts Ultrasound therapy (Group A) significantly improved all measured outcomes, including pain (NPRS), sinus symptoms (SNOT22), and chest expansion at the 2nd ICS, 4th ICS, and xiphoid levels, with highly significant p-values. Low-Level Laser Therapy (LLLT) also significantly reduced pain and sinus symptoms and improved chest expansion at most points, except at the 4th ICS during inspiration,
where the change was not statistically significant.

Inter-Group Analysis

Table 4 : INTER GROUP ANALYSIS Paired Samples Statistics - Group A and Group B

Outcome Measure (Post-Test)	Group	Mean
NPRS_POST	Group A: ULTRASOUND THERAPY	3.40
	Group B: LLLT	3.87
SNOT22QUEST_POST	Group A: ULTRASOUND THERAPY	26.00
	Group B: LLLT	20.87
INSPI_2ndICS_POST	Group A: ULTRASOUND THERAPY	35.81
	Group B: LLLT	31.97
INSPI_4thICS_POST	Group A: ULTRASOUND THERAPY	36.65
	Group B: LLLT	32.35
INSPI_XP_POST	Group A: ULTRASOUND THERAPY	34.61
	Group B: LLLT	32.57
EXP_2ndICS_POST	Group A: ULTRASOUND THERAPY	35.21
	Group B: LLLT	31.33
EXP_4thICS_POST	Group A: ULTRASOUND THERAPY	35.11
	Group B: LLLT	32.17
EXP_XP_POST	Group A: ULTRASOUND THERAPY	33.11
	Group B: LLLT	31.65

The table depicts Ultrasound Therapy (Group A) worked better than LLLT (Group B) for reducing pain, easing sinus symptoms, and improving chest expansion, except at the xiphoid level during inhalation,

where both were equally effective.

Discussion

This study aimed to evaluate and compare the effectiveness of Ultrasound Therapy (UST) and Low-Level Laser Therapy (LLLT) in improving symptoms, pain, and respiratory function in patients undergoing treatment. Despite the informal design utilizing a pre- and post-test model without a control group both treatment modalities demonstrated statistically significant improvements within their respective groups.

These findings suggest that both UST and LLLT can be considered effective therapeutic options for managing the studied condition.

In the present study, ultrasound group has a significant reduction in pain post treatment. Possible reasons for this could be explained as below. It is suggested that the latent amount of heat that is accumulated within the tissues with continuous US may attribute to increase the blood flow in the surrounding regional regions

mucosa[12,13] which have reduced circulation[14] as in cases of chronic sinusitis. Since clearing of the infection is dependent on the blood flow, the authors suggest that healing in the treatment groups may have been facilitated by this increased blood circulation. Thus, ultrasound therapy proved to be more effective for chronic rhinosinusitis. Furthermore, another possible reason for this improvement may be the psychological effect reported for US application. [12] Blockage of sinus ostium occurs due to the mucosal inflammation and then causes retention of secretions that are blocked in the sinus cavities.

Ultrasound therapy causes mechanical vibration of the molecules which might help in the faster drainage and facilitation of the secretions and thus reducing pain. [14,15,16] Another study was done by Nakhostin Ansari *et al*. to study the effect of continuous ultrasound on chronic rhinosinusitis. The results of the trial concluded that continuous ultrasound to be an effective tool in the treatment of chronic rhinosinusitis. The significant effect of ultrasound therapy could also be because of the heating effects of ultrasound. Therapeutic ultrasound when applied to tissues converts into heat, thereby causing molecular vibration which increases the blood supply and helps in reduction of the symptoms experienced in sinusitis. [15]

In the present study, low level laser therapy group also had a significant reduction in pain post treatment.The benefits obtained with LLLT may be explained primarily by anti-inflammatory and anti-bacterial disease-modulating mechanisms (Bjordalet al, 2003; Krespi and Kizhner, 2011). [16,17] In patients with CRS, an increased numbers of neutrophils have been reported (Demoly et al, 1997). [18] The release of local inflammatory mediators (e.g., bradykinin, prostaglandins, and histamine) and cytokines cause CRS symptoms (Eccles, 2011). [19] Several animal studies have shown a reduction in inflammatory cell infiltration after LLLT (Aimbire et al, 2008; Barbosa et al,2008; Pessoa, Melhado, Theodoro, and Garcia, 2004). [20,21] Recently, a review article concluded that LLLT reduces the concentration of signal molecules involved in the inflammatory response, and LLLT can inhibit prostaglandin E2, tumor-necrosis factor α, cyclooxygenase-2, and interleukin 1 beta (Gao and Xing, 2009). [22]All these effects of LLLT are desirable for improving symptoms in patients with CRS. The significant improvement of CRS-related symptoms is important considering that no drugs were prescribed concurrently for the patients.

The addition of the manual drainage techniques helped in easy removal and aiding the drainage of these sinuses into the lymphatic system postthermal production as it would have loosed the sinuses which were filled blocked pus-filled cavities. This removal of waste metabolites helped in reducing the pain

intensity, facial pressure, and the tenderness over the sinuses, thereby additionally improving the symptoms and quality of life in patients suffering from chronic duration sinusitis. (9)

The present study has some limitations. Small sample size, short treatment duration, lack of a control group, and inclusion of manual drainage in both groups limit generalizability and isolation of treatment effects. Outcomes were primarily subjective, and the study was conducted at a single center.

Practical implications are Both therapeutic ultrasound and low-level laser therapy are effective, non-invasive adjuncts for chronic maxillary rhinosinusitis. Ultrasound showed relatively better respiratory improvement and may be clinically preferred in outpatient ENT physiotherapy settings.

Conclusion: Both Ultrasound Therapy and Low-Level Laser Therapy led to significant improvements in symptoms, pain, and respiratory function within their respective groups. However, Ultrasound Therapy showed greater overall effectiveness than Low-Level Laser Therapy in most outcome measures, except for pain reduction, where the difference was not statistically significant.

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