

Role of Mustard Seed Extract Based Hydrogel as an Adjunct to Non-surgical Periodontal Therapy in Chronic Periodontitis Patients: A Pilot Interventional Study

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ABSTRACT

Introduction: Periodontitis is a chronic inflammatory disease that leads to the destruction of both the hard and soft tissues of the periodontium. Various herbal extracts can be used as a Local Drug Delivery (LDD) agent to suppress the inflammation caused by micro-organisms.

Aim: To evaluate the effectiveness of a hydrogel based on mustard seed extract as an adjunct to Non-surgical Periodontal Therapy (NSPT) for the treatment of chronic periodontitis.

Materials and Methods: This pilot interventional study was conducted at Saveetha Dental College and Hospitals, Chennai between June 2023 and July 2023. The study included a total of 30 participants diagnosed with chronic periodontitis who were divided into two groups: group A (n=15) received only Scaling and Root Planing (SRP), while group B (n=15) received SRP along with 0.5% mustard seed extract hydrogel. Baseline and two-week post-operative assessments included recording of Gingival Index (GI), Plaque Index (PI), and modified Sulcus Bleeding Index (mSBI). The data was analysed by Statistical Package for Social Sciences (SPSS), software version 23.0

for windows. An independent t-test was conducted to assess significance between the two groups, while the comparison of baseline and post-operative variables within each group was done using a paired t-test. A p-value of <0.05 was considered statistically significant.

Results: The mean age of study participants was 38.04±8.12 years in group A and 40.36±7.45 years in group B. The group treated with 0.5% hydrogel based on mustard seed extract exhibited a noteworthy enhancement in PI (p<0.05*). Intra-group comparisons revealed a significant difference in baseline and 2-week post-operative values for all parameters except mSBI in group A, although group B showed a significant difference for all the parameters (p<0.05*). Inter-group comparisons at two weeks showed statistically significant improvement in group B for PI but not for GI and mSBI.

Conclusion: The supplemental application of 0.5% hydrogel derived from mustard seed extract alongside SRP yielded promising outcomes, suggesting a novel approach in the management of chronic periodontitis.

Keywords: Adjunctive therapy, Anti-inflammatory, Antibacterial periodontitis, *Brassica nigra*, Innovative hydrogel, Local drug delivery

INTRODUCTION

Chronic periodontitis, a prevalent type of periodontal disease affecting millions globally, is characterised by persistent inflammation and the deterioration of the structures supporting teeth. The primary contributor to this condition is the accumulation of dental plaque, a bacterial biofilm incorporating saliva and food particles on the teeth [1]. Over time, the ongoing inflammation leads to the gradual breakdown of periodontal tissues, causing the gingiva to recede and form pockets that foster bacterial growth. With disease progression, there is a potential impact on the supporting bone, resulting in bone loss and increased tooth mobility [2]. The management of periodontitis typically requires a combination of strategies to effectively address the disease and support oral health.

Two common treatment approaches aimed at combating the bacterial infection associated with periodontitis include systemic antimicrobials (oral antibiotics) and LDD [3,4]. Systemic antimicrobials, which are antibiotics taken orally, enter the bloodstream and circulate throughout the body. These antibiotics can reach periodontal tissues via the bloodstream, targeting bacteria at various oral and systemic sites. However, there is a potential drawback as the prolonged use of systemic antimicrobials may contribute to antibiotic resistance, diminishing their efficacy over time. Moreover, some individuals may experience side-effects or adverse reactions, and there can be contraindications or interactions with other medications [5]. On

the other hand, LDD involves placing antimicrobial agents directly into periodontal pockets or affected gum tissues. The objective is to deliver the drug precisely to the infection site, achieving higher concentrations locally while minimising systemic exposure and associated side-effects. This targeted approach enhances the effectiveness of the anti-microbial agent and may reduce the risk of antibiotic resistance development, as the drug is focused specifically on the affected area [6].

The primary goal of employing LDD is to address bacterial infection, alleviate inflammation, and facilitate tissue healing within the periodontal pocket, particularly in instances where periodontal disease leads to the deepening and intensification of these pockets [7]. LDD is frequently utilised as a supplementary measure alongside NSPT to augment the therapeutic efficacy and enhance outcomes in the management of periodontal diseases. NSPT, also known as SRP or dental cleaning, serves as the initial phase in treating periodontitis. Its primary objective is to eliminate plaque and other causative local factors [8]. A common approach to locally administering drugs involves the use of gel or hydrogel formulations. In the context of treating periodontal diseases through LDD, prevalent drug categories include antibiotics (such as tetracycline or metronidazole), anti-microbial agents (like chlorhexidine), and anti-inflammatory drugs (such as corticosteroids) [9]. Despite the effectiveness of LDD with anti-microbials in addressing periodontal infections, this method

comes with drawbacks and limitations, including the risk of side-effects and the potential for the development of resistance, among other concerns [10].

To mitigate potential side-effects and align with growing patient receptivity towards herbal remedies, the utilisation of herbal extracts has been investigated as potential systems for LDD in managing periodontitis. This exploration is grounded in the antimicrobial, anti-inflammatory, and wound-healing properties exhibited by herbal extracts [11]. As an example, mustard seeds contain bioactive compounds like glucosinolates, which have demonstrated antimicrobial properties and potential health benefits [12]. Some evidence supports the antimicrobial effectiveness of mustard seed extracts against specific bacteria like *E.coli*, *S.aureus*, *P.putida*, *C.albicans*, *P.aeruginosa*, particularly in the realms of food preservation and controlling oral pathogens [13,14]. Despite this, the specific application of mustard seed extracts as an LDD has not been extensively researched or widely incorporated into clinical practice. This study seeks to assess the role of a hydrogel based on mustard seed extract as an adjunct to NSPT in patients with chronic periodontitis.

MATERIALS AND METHODS

During this pilot investigation, 30 individuals (13 males and 17 females; aged between 30 and 48 years) diagnosed with chronic periodontitis were selected from the outpatient division of the Department of Periodontics at Saveetha Dental College in Chennai, India. The research protocol underwent an initial submission to the Institutional Human Ethics Committee (IHEC/SDC/PERIO-2101/23/304). Informed consent was obtained from the patients. This pilot interventional study was conducted from December 2023 to January 2024.

Patients diagnosed with chronic periodontitis (Stage II grade B) were selected and categorised according to the criteria outlined by the American Academy of Periodontology (AAP) in its 2017 classification [15].

Inclusion criteria: Those individuals with a Probing Depth (PD) greater than 5 mm or Clinical Attachment Level (CAL) exceeding 4 mm, coupled with vertical bone loss exceeding 3 mm in intraoral periapical radiographs were included in the study.

Exclusion criteria: Those pregnant women, smokers, individuals with impaired immune systems, and participants who had recently received periodontal therapy were excluded from the study.

Study Procedure

Individuals were randomised into:

- Group A (receiving SRP alone)
- Group B (receiving SRP along with 0.5% mustard seed extract hydrogel) through a simple randomisation process.

SRP alone was performed at the sites in the former group, while in group B, SRP was followed by the application of 0.5% mustard seed extract hydrogel. The site with the maximum PD, CAL, and presence of bleeding on probing was included in the study. Patients were unaware of their group allocation. SRP procedures were conducted until a smooth root surface was achieved. Anti-inflammatory drugs or antibiotics were not prescribed post-treatment. PI [16], GI [17], and modified Sulcus Bleeding Index (mSBI) [18] were recorded at baseline (prior to SRP) and at the 2-week postoperative mark.

An examiner, blinded to the treatment received by the patients, documented all values, while another clinician provided treatment to both groups.

Formulation of hydrogel: The hydrogel derived from mustard seed extract was prepared by boiling three grams of mustard seed powder (obtained from commercially available *Brassica nigra* seeds) in 100 milliliters of de-ionised water at 65°C for four hours. After boiling, the supernatant was discarded, and the resulting pellet underwent

double filtration. This process was repeated twice to obtain the mustard seed extract. Subsequently, Carbopol (50 grams) was added to create the hydrogel [13].

LDD: To ensure uniformity, 0.3 mL of 0.5% hydrogel was injected into the affected sites using a syringe [Table/Fig-1]. Following drug administration, periodontal dressing was not applied due to the viscous nature of the formulation. After hydrogel insertion, patients were advised to avoid consuming hard or sticky foods, refrain from brushing near the treated areas for one week, and abstain from using any interdental aids for a period of two weeks.



[Table/Fig-1]: Administration of hydrogel based on mustard seed extract at the affected site.

STATISTICAL ANALYSIS

Statistical Program for the Social Sciences Version 23.0 for Windows (SPSS Inc., Chicago, IL, USA) was used for statistical analyses. The independent t-test was utilised to assess significance between the two groups, while the comparison of baseline and post-operative variables within each group was conducted using the paired t-test. A significance level of $p < 0.05$ was considered to indicate statistical significance.

RESULTS

There were a total of 30 participants enrolled in the study (15 in each group). No adverse reactions were noted in any patient within group B. The demographic data of the study population were recorded as shown in [Table/Fig-2]. The mean age of study participants was 38.04 ± 8.12 years in group A and 40.36 ± 7.45 years in group B [Table/Fig-2]. Baseline values were compared for Groups A and B, but no significant difference was observed [Table/Fig-3].

Clinical characteristics	Group-A	Group-B
Number of subjects		
Male	7	6
Female	8	9
Total	15	15
Mean age (in years)	38.04 ± 8.12	40.36 ± 7.45

[Table/Fig-2]: Demographic data of study population.

Parameter	Group-A	Group-B	p-value
GI	2.78 ± 0.54	2.74 ± 0.48	0.366
PI	3.86 ± 0.42	3.82 ± 0.36	0.430
mSBI	2.96 ± 0.34	2.95 ± 0.55	0.225

[Table/Fig-3]: Comparison of baseline values of Group-A and Group-B.

Intra-group comparisons revealed a significant difference in baseline and 2-week post-operative values for GI and PI (p -value < 0.05), except for modified Sulcus Bleeding Index (mSBI) (p -value = 0.602) in group A [Table/Fig-4]. Statistically significant

results were obtained between baseline and post-operative values in group B for all parameters (p -value <0.05) [Table/Fig-5]. Inter group comparisons at two weeks showed statistically significant improvement in results for PI (p -value <0.05), but insignificance for GI and mSBI [Table/Fig-6].

Parameter	Baseline	2 weeks post-operative	p-value
GI	2.78±0.54	1.86±0.56	0.002*
PI	3.86±0.42	2.85±0.37	0.003*
mSBI	2.96±0.34	1.35±0.54	0.602

[Table/Fig-4]: Comparison of baseline and two weeks post-operative values of Group-A.

*Significant difference- $p<0.05$

Parameters	Baseline	2 weeks post-operative	p-value
GI	2.74±0.48	1.63±0.42	0.001*
PI	3.82±0.36	2.13±0.31	0.004*
mSBI	2.95±0.55	1.28±0.43	0.003*

[Table/Fig-5]: Comparison of baseline and post-operative values of Group-B.

*Significant difference- $p<0.05$

Parameter	Group-A	Group-B	p-value
GI	1.86±0.56	1.63±0.42	0.223
PI	2.85±0.37	2.13±0.31	0.017*
mSBI	1.35±0.54	1.28±0.43	0.696

[Table/Fig-6]: Comparison of post-operative values of Group-A and Group-B.

*Significant difference- $p<0.05$

DISCUSSION

To enhance the effectiveness of non surgical periodontal treatments, various local therapeutic approaches have been developed. This pilot study specifically examined the application of hydrogels containing mustard seed extract delivered locally as a supplement to NSPT. The exploration of such adjunctive therapy is particularly significant, especially in addressing deep lesions (PD >5 mm +BOP), furcation lesions, or sites that are resistant to standard treatments [19].

In contemporary periodontitis management, SRP is widely acknowledged as the gold standard, demonstrating effectiveness in reducing GI, PI, modified Sulcus Bleeding Index (mSBI), and Probing Depth (PD), as well as promoting Clinical Attachment Level (CAL) gain [20]. However, it is recognised that the local environment around the periodontal pocket can enhance the results of SRP [21]. Consequently, various drugs or compounds have been investigated for their potential to effectively eliminate subgingival microbes through LDD. Regarding the administration of local delivery agents in the affected sites, various drugs have been implicated and assessed [22]. Nevertheless, the increasing demand for natural or herbal alternatives has grown due to the numerous adverse effects of these drugs [23].

The primary drawbacks associated with the utilisation of chlorhexidine and other substances as adjunctive agents delivered locally are the adverse effects induced by these agents. Given the growing preference for natural products, various herbal extracts have undergone testing to assess their anti-inflammatory and antimicrobial properties. Black mustard seeds encompass a notable quantity of sinigrin, a glucosinolate that can undergo hydrolysis to produce Allyl-Isothiocyanate (AITC). It is this compound that accounts for the antimicrobial and anti-inflammatory characteristics of black mustard seeds [24].

To our knowledge, there are no existing studies that document the application of a 0.5% mustard seed extract-based hydrogel as a LDD for the management of chronic periodontitis. As a result, making a direct comparison with other studies is not possible. Nevertheless, there is ample literature examining the effectiveness of herbal or natural extracts as agents for LDD. Some of the frequently used

herbal remedies in recent studies for managing periodontitis include turmeric, babul, neem, green tea, tulsi, aloe, and others.

Behal R et al., employed turmeric gel (2%) as an adjunct to SRP, revealing a noteworthy decrease in the enzymatic activity of microorganisms [25]. Similarly, Pradeep AR et al., conducted a study that highlighted *Acacia arabica*, commonly known as Babul, recognised for its analgesic, anti-inflammatory, and antimicrobial properties as a local delivery agent [26]. In separate investigations, Gadagi JS et al., and Gupta D et al., explored the use of green tea extract and tulsi (*Ocimum sanctum*) extract in the management of periodontitis [27,28]. Additionally, previous literature has already examined the cytotoxicity of *Ocimum sanctum* [29].

The findings from this study indicate that there were no noteworthy disparities in the baseline values between both groups. While there was some amelioration in the post-operative PI and GI values in the untreated group, the modified Sulcus Bleeding Index (mSBI) remained unchanged in group A. In contrast, the application of the hydrogel demonstrated enhanced clinical parameters, exhibiting improvements from baseline to the two-week post-operative values in group B. Additionally, the comparison between the post-operative values across the groups highlighted improved outcomes for PI but remained insignificant for GI and mSBI.

These results are consistent with previous literature that investigated the impact of introducing hydrogel as a supplement to SRP. Given this evidence, it can be inferred that the subgingival application of this hydrogel has the potential to alter the outcomes of NSPT and may thus represent a superior approach for the treatment of periodontitis.

Limitation(s)

The short-term follow-up period was a limitation of this study. Additional extended, randomised, multicenter, double-masked clinical trials involving a substantial population size and thorough examination of microbiologic profiles are essential to further validate the results of this pilot study.

CONCLUSION(S)

This study reveals that the adjunctive use of a 0.5% hydrogel based on mustard seed extract as a LDD agent into the periodontal pockets of individuals with chronic periodontitis resulted in a notable enhancement in clinical status when used alongside NSPT in comparison to NSPT alone.

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