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Efficacy Of Locally Delivered 1%(W/V) Natural Chitosan Gel In Nonsurgical.Treatment Of Chronic Periodontitis: A Split Mouth Study

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ABSTRACT

Introduction: Periodontal pocket elimination is one of the most important goals in the treatment of chronic periodontitis. Scaling, root planing and soft tissue curettage sometimes demonstrates limited success. Systemic antibiotics have been used in different forms of periodontal disease treatment. However, there may be problems associated with the use of systemic antibiotics such as the development of resistant bacteria, and potential side effects. These limitations can be avoided by application of the antimicrobials in local delivery systems directly into the periodontal pocket. Chitosan as a LDD agent has been investigated in the elimination of periodontal pocket.

Objectives: The purpose of this study is to compare the efficacy of Chitosan gel as an adjunct to SRP in nonsurgical management of chronic periodontitis.

Materials and methods:A randomised controlled clinical study was conducted to evaluate the clinical efficacy of chitosan gel in the treatment of PPD in Chronic periodontitis patient. A total of 20 subjects in the age group of 25-50 with chronic periodontitis are categorized into 2 treatment groups: Test group (SRP+ 1% Chitosan gel) and Control group (SRP) in a split mouth study. Various parameters such as PPD, BOP and GI were evaluated after 6 weeks.

Results: Statistical significance is seen in the intra-group comparisons. No statistical difference was observed when intergroup comparison was done in PI and GI but there is significant difference in BOP and PPD.

Conclusion: Chitosan's biocompatibility and inherent antibacterial properties may contribute to enhanced periodontal healing and tissue regeneration.

Keywords: *Chronic periodontitis; PPD; LDD; chitosan gel.*

1. INTRODUCTION

Periodontal disease affects the structures supporting teeth, leading to the loss of periodontal ligament and alveolar bone. The primary goal of therapy is to regenerate lost tissue, often using mechanical debridement and adjunctive antibiotic therapy[1].

Choosing the right antimicrobial agent and administration route is crucial for effective treatment[2]. Goodson et al. (1970) observed that local drug delivery systems provide several advantages over systemic administration, including direct access to target sites, improved compliance, and enhanced drug efficacy. These systems can be in the form of fibers, gels, strips, films, and more.

Common synthetic drugs used for local delivery include doxycycline, minocycline, metronidazole, and chlorhexidine. However, synthetic drugs can lead to bacterial resistance, degradation issues, and cost concerns[3]. The challenging environment of the oral cavity necessitates the development of effective carrier systems, and natural polymers have been beneficial in overcoming these challenges.

In 1811, Braconnot discovered chitin from fungi, initially naming it "forgine." Later, it was renamed chitin by Edier, and Hoppe-Seyler subsequently referred to it as chitosan in 1894[4]. Chitin is derived from the skeletal material of arthropods and is also found in the cell walls of fungi. When chitin undergoes 70% deacetylation, it transforms into chitosan. This linear polymer consists of β (beta) 1-4 glycosylamine units.

Chitosan's high biocompatibility, along with its high viscosity and water-binding capacity, makes it suitable for various applications, including gels, chips, and membranes. It is non-allergenic, non-toxic, and possesses bio-functional properties[5]. Additionally, chitosan exhibits antibacterial activity against both gram-positive and gram-negative bacteria, as well as anti-inflammatory and wound-healing properties. Its other notable characteristics include hemostatic, fungistatic, antitumor, anti-cholesteric, and immunoadjuvant effects[3].

2. MATERIALS AND METHODS

The present study involved 20 patients, comprising 12 males and 8 females, aged between 25 and 50 years, all diagnosed with chronic periodontitis. These patients were treated in the outpatient section of the Department of Periodontics at the Government Dental College and Hospital in Kadapa. The study protocol received approval from the institution's ethical committee and review board (Pr.001/IEC/GDCH/2024-25/01). After providing a thorough explanation of the clinical trial design, nature, and potential risks, signed written informed consent was obtained from all patients. The participants were divided into two treatment groups: the test group, which received scaling and root planning (SRP) combined with 1% chitosan, and the control group, which received SRP alone.

3. OBJECTIVES

The study aims to compare the efficiency of chitosan gel as an adjuvant to SRP in the non-surgical management of generalized chronic periodontitis.

4. INCLUSION AND EXCLUSION CRITERIA

Systemically healthy patients in the age group of 30-55 years with probing periodontal pockets of 5-7mm without gingival recessions and without any prior periodontal surgery and no medication known to interfere with periodontal healing or health, non-smokers, former smokers (who doesn’t smoke now and hasn’t smoked for the past 12 consecutive months were included in the study. The exclusion criteria consisted of individuals with intrabony defects, furcation involvement, current smokers, pregnant and lactating women, those with known allergies to chitosan, and immunocompromised patients.

5. PROCEDURE

A randomized split-mouth study was conducted, with 20 sites assigned as test sites and 20 sites as control sites. A well-calibrated examiner recorded all clinical parameters to ensure unbiased measurements using a UNC 15 manual probe (Hu Friedy, Illinois, Chicago). The clinical parameters assessed included Probing Pocket Depth (PPD; Sillness and Loe, 1964), Gingival Index (GI; Loe and Sillness, 1963), Relative Attachment Level and Bleeding on Probing Index (BOP; Ainamo and Bay, 1975) both at baseline and 6 weeks postoperatively in control and test sites.

The UNC 15 periodontal probe was utilized for all clinical measurements in control sites (fig 1 and fig 2) and in test sites sites (fig 4 and fig 6) to ensure reproducibility at subsequent intervals.The ancillary parameters evaluated in the study included the Plaque Index, specifically the Turesky-Gilmore-Glickman modified Quigley-Hein plaque index, and the Modified Gingival Index developed by Lobene et al. in 1986.

A 1% (w/v) resorbable chitosan gel was applied to the test sites two days after Scaling and Root planning (SRP) was performed. The SRP procedure utilized ultrasonic scalers and Gracey curettes. The 1% chitosan gel was injected into the periodontal pockets using a blunt cannula until the pockets were filled (fig 5). After the gel was placed, Coe-Pak was applied to secure it.

FIG:1 Control group Pre operative

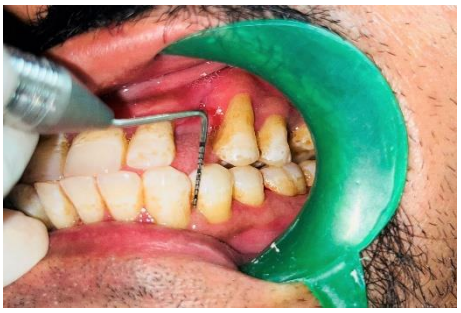


FIG:2 control group Post operative

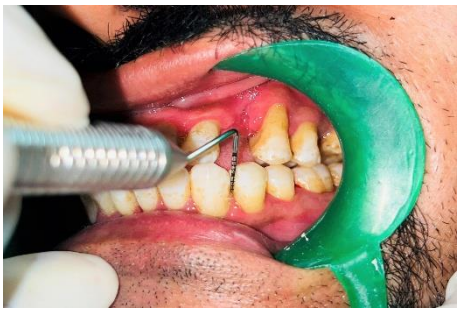


FIG:3 Test group Pre operative

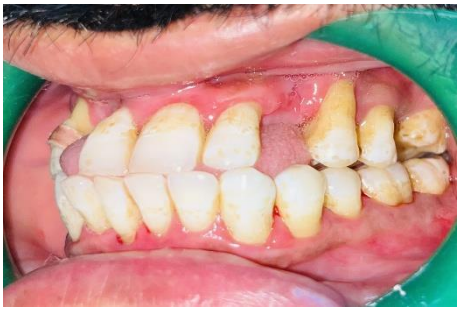


FIG:4 Pre operative pocket depth

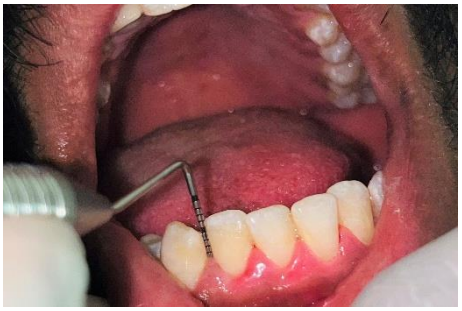


FIG:5 LDD OF 1% Chitosan gel

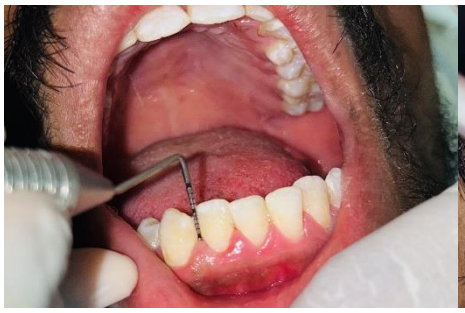
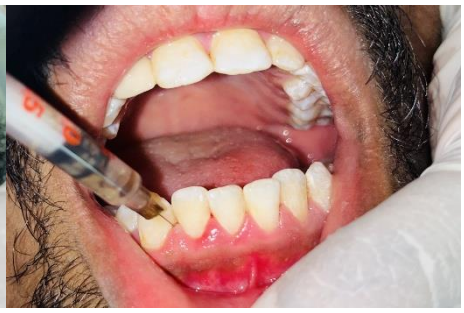


FIG:6 six weeks Post operative



6. STATISTICAL ANALYSIS

Statistics were computed using SPSS version 23. Student t-tests were used for intragroup comparison between the baseline and 6 weeks of the A group (SRP) and B group (SRP with the chitosan). Interdependent t-test was used for intergroup comparison between A and B groups. Statistical significance is seen in the intra-group comparisons. (table 1 and table 2). No statistical difference was observed when intergroup comparison was done in PI and GI but there is significant difference in BOP and PPD (table 3 and table 4).

Table 1: Intragroup comparison between baseline and after 6 weeks in the SRP group

Intragroup comparison between baseline and after 6 weeks in the A group (SRP)				
		t statistic	**P value**	**(Means ± SD)**
PI at baseline	**PI after 6 weeks**	7.17	< 0.01*	1.45 ± 0.20
GI at baseline	**GI after 6 weeks**	38.07	< 0.01*	1.97 ± 0.05
BOP at baseline	**BOP after 6 weeks**	6.07	< 0.01*	1.44 ± 0.23
PPD at baseline	**PPD after 6 weeks**	7.75	< 0.01*	2.00 ± 0.25

SD: standard deviation, PI: plaque index, GI: Gingival index, BOP: Bleeding on probing, PPD: periodontal probing depth, P<0.05*: statistically significant

Table 2: Intragroup comparison between baseline and after 6 weeks in the SRP with chitosan group

Intragroup comparison between baseline and after 6 weeks in the B group (SRP with chitosan)				
		t statistic	**P value**	**(Means ± SD)**
PI at baseline	**PI after 6 weeks**	12.7	< 0.01*	2.16 ± 0.17
GI at baseline	**GI after 6 weeks**	30.7	< 0.01*	2.10 ± 0.06
BOP at baseline	**BOP after 6 weeks**	16.5	< 0.01*	2.20 ± 0.13
PPD at baseline	**PPD after 6 weeks**	12.2	< 0.01*	2.36 ± 0.19

SD: standard deviation, PI: plaque index, GI: Gingival index, BOP: Bleeding on probing, PPD: periodontal probing depth, P<0.05*: statistically significant

Table 3: Intergroup comparison between baseline and after 6 weeks in the SRP group

Intergroup comparison between baseline and after 6 weeks in the A group (SRP)				
		t statistic	**P value**	**Means ± SD**
PI at baseline	**PI after 6 weeks**	0.575	0.572	0.14 ± 0.24
GI at baseline	**GI after 6 weeks**	-0.706	0.489	-0.06 ± 0.08
BOP at baseline	**BOP after 6 weeks**	-13.217	< 0.01*	-3.21 ± 0.24
PPD at baseline	**PPD after 6 weeks**	-11.422	< 0.01*	-2.96 ± 0.25

SD: standard deviation, PI: plaque index, GI: Gingival index, BOP: Bleeding on probing, PPD: periodontal probing depth, P<0.05*: statistically significant

Table 4: Intergroup comparison between baseline and after 6 weeks in the SRP and chitosan group

Intergroup comparison between baseline and after 6 weeks in the A group and group B (SRP)				
		t statistic	**P value**	**Means ± SD**
PI at baseline	**PI after 6 weeks**	4.14	< 0.01*	0.57 ± 0.13
GI at baseline	**GI after 6 weeks**	4.55	< 0.01*	0.19 ± 0.04
BOP at baseline	**BOP after 6 weeks**	2.45	<0.02*	0.40 ± 0.16
PPD at baseline	**PPD after 6 weeks**	3.98	< 0.01*	0.87 ± 0.21

SD: standard deviation, PI: plaque index, GI: Gingival index, BOP: Bleeding on probing, PPD: periodontal probing depth, P<0.05*: statistically significant

7. RESULTS

There were no dropouts in the study and all the subjects were followed till the end of the study period. No clinically apparent adverse effects were observed in any of the patients following the intervention.

All clinical parameters improved significantly in both groups over course of periodontal therapy from baseline to 6 weeks post operative period. Statistically significant results were seen in the intragroup comparisons in clinical parameters i.e PI, GBI, BOP, PPD. There is also noticeable change in the clinical parameters such as BOP and PPD but there is no significant change in the PI and GI in the inter group comparison.

8. DISCUSSION

Various surgical and non-surgical therapies have been successfully used to treat periodontitis. However, in cases of localized periodontitis where flap reflection is not possible, isolated defects are treated with SRP and LDD. Chitosan is a linear polysaccharide derived from the deacetylation of chitin and is the second most abundant biopolymer after cellulose. It has gained attention for its biocompatibility, biodegradability, non-toxicity, mucosal adhesion, and ease of chemical modification.

Chitosan also exhibits various beneficial biological properties, including antifungal and antibacterial effects, anti-inflammatory action, immune enhancement, antioxidant capabilities, and wound healing. Additionally, it serves as a chelating agent, selectively binding trace metals and inhibiting toxin formation and microbial growth[5]. The study shows a significant reduction in bleeding on probing, Gingival index, and plaque index scores from baseline to 6 weeks, attributed to its anti-inflammatory, anti-tumor, and wound healing properties[6].

In this study, the chitosan biopolymer, used in a gel form (1% w/v), demonstrated effectiveness in treating periodontal pocket depths of 5-7 mm. According to Dhlen G and J. Lindhe, there were significant changes in the quantity and composition of subgingival microbiota, as well as improvements in clinical symptoms associated with periodontitis, among patients who cooperated in maintaining good oral hygiene and who received careful supragingival plaque control.

Similar results were reported in studies conducted by Hakan Akncbay et al., Irfana S et al., and Marco Cicciu et al. They evaluated the clinical effectiveness of chitosan, both as a carrier in gel form and as an active agent in the treatment of chronic periodontitis (CP). The researchers compared three groups: Group A received chitosan at 1% w/v, Group B received chitosan gel at 1% w/v combined with 15% metronidazole, and Group C received scaling and root planning (SRP) alone. Significant improvements were observed in all groups from baseline to 24 weeks ($P < 0.05$). The reduction in probing depth (PD) values was 1.21 mm for Group A (chitosan), 1.48 mm for Group B (chitosan + metronidazole), and 0.94 mm for Group C (SRP alone). The findings suggest that chitosan is effective on its own, as well as in combination with metronidazole, in the treatment of chronic periodontitis due to its antimicrobial properties[7].

Irfana S. Babrawala and colleagues conducted a study to evaluate the effectiveness of 1% (w/w) resorbable chitosan membranes as an adjunct to scaling and root planing (SRP) in the non-surgical treatment of chronic periodontitis. The mean difference in probing pocket depth (PPD) between the test and control groups was 1.4 mm. Additionally, the mean ± standard deviation (SD) for gingival index (GI) in the test group was 0.20 ± 0.42 at 6 weeks[8].

A study conducted by Mohammed Gulzar Ahmed, NM Harish, R. Narayana Charyulu, and colleagues suggests that a crosslinked chitosan film containing ciprofloxacin and diclofenac could serve as an effective drug delivery device for the topical treatment of periodontitis[9]. The films demonstrated favorable physicochemical properties. Sreeja Sarkar, Vandana Kangowkar, and Shobha Prakash conducted an in vitro study to assess the efficacy of a 1% chitosan gel against periodontal pathogens. The results indicated that the gel produced the largest zone of inhibition against Fusobacterium nucleatum, and there was a significant absence of bacterial growth where Porphyromonas gingivalis, Prevotella intermedia, and Tannerella forsythia were introduced. These findings suggest that chitosan gel may have potential use in the treatment of chronic periodontitis[10].

Chitosan is utilized as a film matrix for delivering both hydrophilic and hydrophobic drugs, extending the drug's residence time at the application site[11]. It is also involved in the creation of bioadhesive buccal films[12]. Shiqing Ma, Xuemei Lu, Xinying Yu, and colleagues conducted a study that involved the development of an antibacterial and antioxidant therapeutic regimen using a chitosan-based hydrogel. The results indicated that chitosan can effectively release Nal-P-113 and PDNPs for up to 13 days. The hydrogel demonstrated a scavenging activity of approximately 80% against DPPH for S. gordonii and F. nucleatum, while it exhibited around 99% effectiveness against P. gingivalis. These findings suggest that chitosan-based hydrogels could serve as a foundation for multifunctional local drug delivery biomaterials aimed at treating periodontitis[13].

9. CONCLUSION

Chitosan's biocompatibility and inherent antibacterial properties may contribute to enhanced periodontal healing and tissue regeneration. These findings support the potential of chitosan as a viable adjunctive therapy in the management of periodontal disease, offering a promising direction for future research and clinical application in periodontal therapies. Further studies with larger sample sizes and longer follow-up periods are warranted to confirm these results and explore the mechanisms behind the observed improvements in periodontal health. The results encourage the exploration of natural polymers like chitosan in periodontal therapy, potentially leading to more effective and patient-friendly treatment options.

Declarations

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Conflict of Interest

The Author declares that there is no conflict of interest.

Ethical Approval

This study was approved by institutional ethical committee (Pr.001/IEC/GDCH/2024-25/01).Signed in informed consent from patients were taken prior to the procedure

Availability of data and materials

From the institution(GDCH, Kadapa,Andhra Pradesh)

Consent for publication

Not applicable

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