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Efficacy of Curcumin Chip / Gel with Scaling and Root Planning in Treating Stage II-III Periodontitis: A Prospective Comparative Study

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Abstract: ***Introduction**: Periodontitis damages tooth-supporting tissues and is treated primarily with scaling and root planning (SRP). Challenges include fully eradicating bacteria and promoting tissue regeneration. Curcumin from Curcuma longa has anti-inflammatory, antimicrobial, and antioxidant properties, hence making it a helpful adjunct in periodontal therapy. **Objective**: The study aims to compare the clinical efficacy of SRP alone/ with curcumin chip, or with curcumin gel in patients with Stage II and III periodontitis. **Methodology**: A prospective, randomised, controlled clinical study has been conducted on 45 systemically healthy patients diagnosed with Stage II and Stage III periodontitis. Patients were randomly allocated into three comparative groups of 15 patients each: Group A (SRP with subgingival placement of a curcumin gel), Group B (SRP with subgingival application of a curcumin chip) Group C (SRP alone). Clinical parameters, including the Gingival index (Loe and Silness), Probing pocket depth (PPD), Clinical attachment level (CAL), Bleeding on probing (BOP), and Plaque index (PI), will be recorded at baseline and 1-month post-treatment. **Results**: In the present study, the Plaque Index (PI) showed a significant reduction in all three groups after one month. Group A (Curcumin Gel) exhibited a mean reduction of 0.86 ± 0.41, Group B (Curcumin Chip) demonstrated the greatest reduction of 1.68 ± 0.52, and Group C (SRP alone) showed a reduction of 0.44 ± 0.36. Regarding the Gingival Index (GI), all groups showed improvement after treatment. Group A (Curcumin Gel) had a mean reduction of 1.53 ± 0.48, Group B (Curcumin Chip) 1.56 ± 0.51, and Group C (SRP alone) 0.86 ± 0.44. For Probing Pocket Depth (PPD) reduction, Group A (Curcumin Gel) displayed a mean reduction of 2.94 ± 0.89 mm, Group B (Curcumin Chip) 2.86 ± 0.93 mm, and Group C (SRP alone) 2.07 ± 0.81 mm. In terms of Clinical Attachment Level (CAL) gain, Group A (Curcumin Gel) showed an average improvement of 2.53 ± 0.84 mm, Group B (Curcumin Chip) 2.74 ± 0.91 mm, and Group C (SRP alone) 2.27 ± 0.79 mm. **Conclusion**: The adjunctive use of curcumin as an LDD in the form of both chip and gel showed efficacy in treating periodontitis. Although the curcumin chip demonstrated slightly better results compared to the curcumin gel in terms of gain in clinical attachment and improvement in plaque index.*

Keywords: Curcumin gel, curcumin chip, local drug delivery, herbal LDD for periodontitis, Scaling and root planning, periodontitis treatment

1. Introduction

Periodontitis is an inflammatory disease affecting the supporting structures of the teeth. The primary etiological factor in gingivitis, which may later progress to periodontitis, is bacterial plaque. Periodontal therapy mainly focuses on mechanical debridement of tooth surfaces followed by proper maintenance of oral hygiene. However, complete elimination of irritants cannot always be achieved through mechanical debridement alone. Therefore, antibiotics and antiseptics have been used in both systemic and local forms as adjuncts to therapy.(1) The use of systemic antibiotics often requires higher dosages to achieve adequate concentration at the disease site, which may increase the risk of developing bacterial resistance.(1) Local drug delivery (LDD) systems provide an alternative approach to systemic antibiotic therapy. These delivery systems have shown effectiveness against subgingival microflora.(1) Various LDD systems enable targeted delivery of antimicrobial agents and include fibres, strips and compacts, gels, microparticles, films, and nanoparticles.

(6) *Curcuma longa*, a member of the ginger family, is native to Southeast Asia. The rhizome of *Curcuma longa*, commonly known as turmeric, is a yellow-orange spice. The principal components of turmeric include curcumin (diferuloylmethane), demethoxycurcumin, and bisdemethoxycurcumin. Curcumin possesses several biological properties and is widely used as an anti-inflammatory, antimicrobial, antineoplastic agent, flavouring agent, natural pigment, and lipoxygenase inhibitor. It is considered a non-toxic compound even at higher doses.(6) The anti-inflammatory activity of curcumin is well documented in the literature and is attributed to its ability to inhibit lipoxygenase and cyclooxygenase activity in humans.(1) The use of curcumin as a local adjunct in combination with scaling and root planing (SRP) has demonstrated improvements in periodontal parameters.(2)(3)(4) Additionally, previous studies have reported no statistically significant difference between chlorhexidine gel and curcumin gel with respect to plaque index and gingival index.(5) Therefore, the present study aims to compare the efficacy of Curcumin Chip and Curcumin Gel as adjuncts to scaling and root planing in the treatment of Stage II–III periodontitis.

2. Aims and Objectives

To compare the effectiveness of Curcumin Chip/Gel with Scaling and Root Planning in treating Stage II-III Periodontitis, using oral hygiene index, plaque index, gingival index, probing pocket depth, and clinical attachment loss at baseline and after 4 weeks

3. Materials and Methods

A randomised controlled clinical trial was done with a sample size of 45 systemically healthy patients randomly allocated into three comparative groups of 15 patients each: Group A (SRP with subgingival placement of a curcumin gel), Group B (SRP with subgingival application of a curcumin chip), and Group C (SRP alone). This study

obtained ethical clearance from the institutional ethical committee with reference number "AME/DC/402/25-26"
The sample size for the present study was calculated by considering a Level of Significance (α) of 5% and Power of the study (1−β) of 80%. The calculation was performed assuming the outcome variable on a ratio scale and testing the null hypothesis that there is no significant difference

Sample Size Formula:

$$n = \frac{2\sigma^2(Z_{\alpha/2} + Z\beta)^2}{d^2}$$

Where:

- **n** = Sample size required in each group
- **σ²** = Variance of the outcome variable (σ = standard deviation)
- **d** = Expected difference in means between groups (effect size)
- **Zα/2** = Standard normal deviate corresponding to **level of significance (α)**
- **Zβ** = Standard normal deviate corresponding to **power (1−β)**

A power analysis was carried out using G*Power software version 3.0.1 (Franz Faul, Universität Kiel, Germany). Based on the expected effect size from previous similar periodontal clinical studies, the minimum required sample size was calculated to be 45 subjects.

All patients who expressed interest in participating in the study provided informed written consent. Patients were evaluated for Plaque index (Sillness and Loe) and Gingival index (Loe and Sillness), probing pocket depth, and Clinical attachment loss at baseline and after 4 weeks. Plaque index was evaluated with the help of two tone die. In both Group A and Group B, after placing the LDD pack was placed for 1 week.

Method of preparation of curcumin gel:
To prepare the curcumin gel, 100 mg of Carbopol was taken and placed into a clean, dry glass jar which is then added with 20 mg of powdered curcumin to the jar, ensuring the powder is evenly distributed. Slowly pour in 10 ml of distilled water while stirring continuously to facilitate mixing. Then, add 2-3 drops of Triethanolamine to adjust the pH and aid in the gel formation. Mix thoroughly until a homogeneous gel is formed, resulting in a smooth and stable curcumin gel.

Method of preparation of curcumin film:
Oral films of Curcumin were prepared by solvent casting technique. The different

Calculation of dose for Curcumin:
The dose of Curcumin as reported is 2.5 mg daily by mouth. In order to formulate oral films, the lowest dose is selected. So the total amount of dose to be incorporated would be 2.5 mg per one film per day. The total amount of drug to be incorporated in the petri dish of the film drug delivery system is shown as follows,

Internal diameter of Petri plate = 6 cm Radius of Petri plate = 3 cm;

Area of Petri plate = πr^2
= 3.14 x 3 x 3
= 28.26 cm^2

Area of Film = 0.5 cm^2

Dose of Curcumin in 1 film = 2.5 mg

For 0.5 cm^2 area of film = 2.5 mg Curcumin So, for 28.26 cm^2 area of Petri plate
2.5/0.5 X 28.26 = 141.3 mg of Curcumin

Therefore, 141.3 mg of Curcumin is needed to be incorporated for casting film in Petri plate.

Formula
Curcumin - 141.3 mg HPMC E5- 500 mg HPC- 250 mg
Distilled water: Ethanol-10 ml (7:3)

Method of preparation: Dissolved accurately weighed quantities of Curcumin, HPMC E5 and HPC as per the formula in a 7:3 mixture of Distilled water and Alcohol.

Stirred the mixture for 1 hour and sonicated for 10 minutes to remove the entrapped air bubbles. The prepared solution was cast onto a 6 cm diameter petridish and dried in the oven at 60°C for 12 hr. The film was removed from the petridish and cut to the required size for testing (1x 0.5 cm squares) per film. The films were wrapped in aluminium foil and stored in a glass container for further studies.

Figure representing curcumin film preparation, Curcumin chip (4×5mm)

4. Results

In the present study the Plaque Index (PI) showed a marked reduction in all three groups after one month. Group A (Curcumin Gel) demonstrated a mean reduction of 0.86 ± 0.41, Group B (Curcumin Chip) showed the highest reduction of 1.68 ± 0.52, and Group C (SRP alone) showed a reduction of 0.44 ± 0.36. One-way ANOVA revealed a highly significant intergroup difference ($F = 24.37$, $p < 0.001$). Tukey post hoc analysis demonstrated that Curcumin Chip produced significantly greater plaque reduction compared to Curcumin Gel and SRP alone ($p < 0.001$). Additionally, Curcumin Gel showed significantly greater plaque reduction compared to SRP alone ($p = 0.032$).

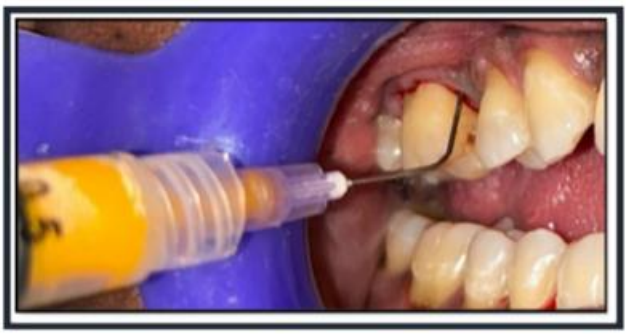
For the Gingival Index (GI), all groups exhibited improvement after treatment. Group A (Curcumin Gel) showed a mean reduction of 1.53 ± 0.48, Group B (Curcumin Chip) 1.56 ± 0.51, and Group C (SRP alone) 0.86 ± 0.44. ANOVA indicated a statistically significant difference among the groups ($F = 7.82$, $p = 0.001$). Tukey post hoc comparisons revealed no significant difference between Curcumin Gel and Curcumin Chip ($p = 0.971$), while both adjunctive therapies showed significantly greater gingival improvement compared to SRP alone ($p = 0.003$ and $p = 0.002$, respectively).

With respect to Probing Pocket Depth (PPD) reduction, Group A (Curcumin Gel) showed a mean reduction of 2.94 ± 0.89 mm, Group B (Curcumin Chip) 2.86 ± 0.93 mm, and Group C (SRP alone) 2.07 ± 0.81 mm. ANOVA analysis revealed a significant intergroup difference ($F = 5.14$, $p = 0.010$). Tukey post hoc analysis indicated no significant difference between Curcumin Gel and Curcumin Chip ($p = 0.928$). However, both groups showed significantly greater pocket depth reduction compared to SRP alone ($p = 0.018$ and $p = 0.026$ respectively). In terms of Clinical Attachment Level (CAL) gain, Group A (Curcumin Gel) showed a mean improvement of 2.53 ± 0.84 mm, Group B (Curcumin Chip) 2.74 ± 0.91 mm, and Group C (SRP alone) 2.27 ± 0.79 mm. ANOVA showed a significant difference among the groups ($F= 3.62$, $p = 0.035$). Tukey post hoc comparisons revealed no significant difference between Curcumin Gel and Curcumin Chip ($p = 0.604$) or between Curcumin Gel and SRP alone ($p = 0.472$). However, Curcumin Chip demonstrated significantly greater clinical attachment gain compared to SRP alone ($p = 0.041$).

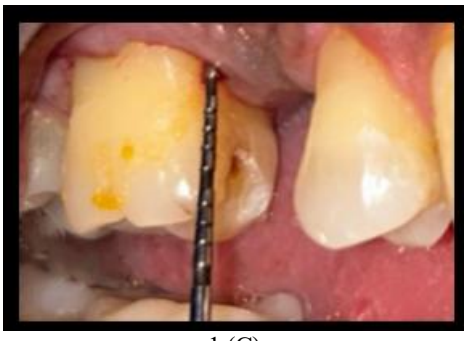
Overall, the results indicate that both Curcumin Gel and Curcumin Chip used as adjuncts to SRP provide superior clinical outcomes compared to SRP alone, with Curcumin Chip group showed comparatively greater improvements in plaque reduction and clinical attachment gain.

No adverse events were recorded with neither curcumin chip nor the curcumin gel in the limitation period of this study.

1 (A)

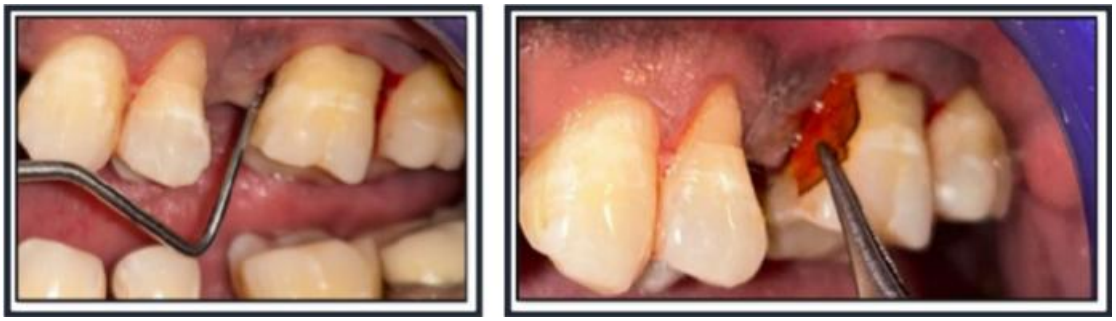


1 (B)



1 (C)

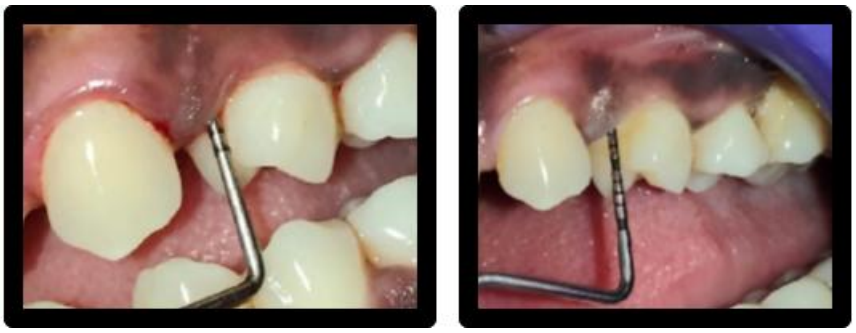
Figure 1 (A) Representing baseline pocket depth measurement, 1 (B) Representing curcumin gel placement, 1 (C) Representing post 4 weeks pocket depth measurement.



2 (A) 2 (B)

2 (C) 2(D)

Figure 2: (A) Representing baseline pocket depth measurement, 2 (B) Representing curcumin chip placement, 2 (C) Representing coe pak placement after LDD placement, 2 (D) Representing post 4 weeks pocket depth measurement.



3 (A) 3 (B)

Figure 3: (A) Reprsenting pocket depth measurement at baseline, 3 (B) Representing pocket depth measurement post 4 weeks.

Index	Group A (Curcumin Gel)	Group B (Curcumin Chip)	Group C (SRP Alone)
Plaque parameter (PI)			
Mean Baseline	1.9	2.12	1.25
Mean 1 Month	1.04	0.44	0.81
Mean Reduction	0.86	1.68	0.44
Gingival Parameter (GI)			
Mean Baseline	2.68	2.37	1.63
Mean 1 Month	1.15	0.81	0.77
Mean Reduction	1.53	1.56	0.86
Probing Pocket Depth (PPD)	(mm)	(mm)	(mm)
Mean Baseline	6.27	6.73	7
Mean 1 Month	3.33	3.87	4.93
Mean Reduction	2.94	2.86	2.07
Clinical Attachment Loss (CAL)	(mm)	(mm)	(mm)
Mean Baseline	3.2	3.87	4
Mean 1 Month	0.67	1.13	1.73
Mean Reduction	2.53	2.74	2.27

Table representing description of mean changes in clinical parameters from baseline.

Group	Mean ± SD	F value	p value
Group A (Gel)	0.86 ± 0.41	24.37	<0.001*
Group B (Chip)	1.68 ± 0.52		
Group C (SRP)	0.44 ± 0.36		
Tukey Post Hoc Comparisons			
Pairwise comparison	Mean Difference	P value	
A vs B	-0.82	<0.001**	
A vs C	0.42	0.032*	
B vs C	1.24	<0.001**	

Tabe representing plaque index analysis

P>0.05 – no significant difference

***p<0.05 – significant **p<0.001 – highly significant**

Group	Mean ± SD	F value	p value
Group A (Gel)	1.53 ± 0.48	7.82	0.001*
Group B (Chip)	1.56 ± 0.51		
Group C (SRP)	0.86 ± 0.44		
Tukey Post Hoc Comparisons			
Pairwise comparison	Mean Difference	P value	
A vs B	-0.03	0.971 (NS)	
A vs C	0.67	0.003*	
B vs C	0.7	0.002*	

Group	Mean ± SD	F value	p value
Group A (Gel)	2.94 ± 0.89	5.14	0.010*
Group B (Chip)	2.86 ± 0.93		
Group C (SRP)	2.07 ± 0.81		

Table representing Gingival index analysis

P>0.05 – no significant difference

*p<0.05 – significant **p<0.001 – highly significant

Tukey Post Hoc Comparisons		
Pairwise comparison	Mean Difference	P value
A vs B	0.08	0.928 (NS)
A vs C	0.87	0.018*
B vs C	0.79	0.026*

Group	Mean ± SD	F value	p value
Group A (Gel)	2.53 ± 0.84	3.62	0.035*
Group B (Chip)	2.74 ± 0.91		
Group C (SRP)	2.27 ± 0.79		
Tukey Post Hoc Comparisons			

Table representing PPD

P>0.05 – no significant difference

*p<0.05 – significant **p<0.001 – highly significant

Pairwise comparison	Mean Difference	P value
A vs B	-0.21	0.604 (NS)
A vs C	0.26	0.472 (NS)
B vs C	0.47	0.041*

Table representing CAL

P>0.05 – no significant difference

*p<0.05 – significant **p<0.001 – highly significant

5. Discussion

The primary goal of periodontal therapy is to reduce the microbial load through mechanical debridement and adjunctive treatment modalities, thereby improving clinical parameters such as Plaque Index, Gingival Index, and Probing Pocket Depth. Scaling and root planning (SRP) remains the gold standard in periodontal therapy and is often complemented with various adjunctive approaches to enhance treatment outcomes.[1] Local drug delivery (LDD) systems have gained considerable attention due to their ability to improve therapeutic outcomes by delivering antimicrobial agents directly to the site of infection. This targeted delivery allows higher drug concentrations at the diseased site while minimizing systemic side effects.[8] The use of synthetic antimicrobials and antibiotics has been associated with the development of antimicrobial resistance, as evidenced by the emergence of resistant infections.[12][8] Consequently, natural phytochemicals have been increasingly explored as effective alternatives to synthetic agents.[12] Curcumin, a natural polyphenolic compound derived from the turmeric plant, possesses several beneficial properties including anti-inflammatory, antioxidant, antibacterial, and wound healing activities, making it a promising adjunct in periodontal therapy.[1] Curcumin has demonstrated significant antimicrobial activity against key periodontal pathogens such as *Porphyromonas gingivalis*, *Fusobacterium nucleatum*, and *Prevotella intermedia*.[9] Furthermore, it has been reported to modulate the host immune response, which is particularly important in periodontal disease where inflammation plays a central role.[8] The antimicrobial effect of curcumin is believed to be related to its ability to inhibit bacterial lipopolysaccharide-induced cytokine production and interfere with bacterial quorum sensing mechanisms.[12] In addition, curcumin inhibits biofilm formation and facilitates the disruption of existing microbial biofilms.[1] This property may also contribute to the reduction in plaque scores observed following its application.[12] Curcumin has also been reported to accelerate wound healing by increasing fibronectin levels and promoting epithelial cell migration to the wound site.[7] In the present study periodontal parameters were evaluated after 4 weeks as this is justified by the study done by Segelnick SL, Weinberg MA .In the present study, Curcumin Chip produced significantly greater plaque reduction compared to Curcumin Gel and SRP alone. Moreover, Curcumin Gel demonstrated significantly greater plaque reduction than SRP alone. The Plaque Index (PI) serves as an important indicator of oral hygiene status and is closely associated with the initiation and progression of periodontal disease. A reduction in PI following treatment reflects improved plaque control and indicates the effectiveness of local drug delivery agents in reducing microbial load. [8] The Gingival Index (GI) evaluates the severity of gingival inflammation based on parameters such as colour, consistency, and bleeding on probing, and is considered a reliable indicator of gingival inflammatory status. In this study, assessment of changes in GI values helped determine the anti-inflammatory potential of curcumin when used as a local drug delivery system. [8] The results showed no statistically significant difference between Curcumin Gel and Curcumin Chip, although both adjunctive therapies produced significantly greater reductions in gingival inflammation compared to SRP alone. The anti-inflammatory effect of curcumin on gingival tissues may be attributed to its mechanism of selectively inhibiting the synthesis of prostaglandin E2 and thromboxane while not affecting prostacyclin synthesis.[1] In the present study, Curcumin Chip demonstrated significantly greater clinical attachment gain compared to SRP+gel and SRP alone. Similar findings have been reported in another study that compared three groups receiving different local drug delivery systems: SRP with pomegranate chip, SRP with pomegranate gel,

and SRP alone.[13] Furthermore, both Curcumin Gel and Curcumin Chip groups in the present study showed significantly greater probing pocket depth reduction compared to SRP alone. Comparable findings were reported in a meta-analysis which demonstrated a significant reduction in probing pocket depth in groups receiving curcumin as a local drug delivery agent, possibly due to its anti-inflammatory and wound healing properties. [1] However, in contrast, a study conducted by Tyagi P comparing pomegranate in gel and chip forms reported that the gel formulation produced greater improvements in plaque index, gingival index, and probing pocket depth, whereas the chip form showed greater effectiveness in improving relative attachment levels. [13] Overall, the findings of the present study indicate that both Curcumin Gel and Curcumin Chip used as adjuncts to SRP produced superior clinical outcomes compared to SRP alone with respect to plaque index (PI), gingival index (GI), probing pocket depth (PPD), and clinical attachment level (CAL). Similar observations were reported in a randomised controlled trial comparing curcumin gel with SRP versus SRP alone, where improved clinical parameters were observed and no adverse effects were reported, highlighting the safety and effectiveness of curcumin as an adjunctive therapy. [10] Thus, the present study suggests that curcumin, when used in the form of either gel or chip, is effective in improving periodontal parameters when used as an adjunct to SRP. However, certain limitations should be acknowledged, including the short follow-up period, limited sample size, and absence of microbiological assessment.

6. Conclusion

Within the limitations of the present study, the results demonstrated that the adjunctive use of curcumin-based local drug delivery systems along with scaling and root planning (SRP) produced superior clinical outcomes compared to SRP alone in the management of periodontal disease. Both Curcumin Gel (Group A) and Curcumin Chip (Group B) showed significant improvements in plaque index, gingival index, probing pocket depth reduction, and clinical attachment level gain when compared with SRP alone (Group C) after one month. Among the tested interventions, the Curcumin Chip demonstrated comparatively greater plaque reduction and clinical attachment gain, indicating a slightly superior therapeutic benefit. The findings also suggest that curcumin-based local drug delivery, particularly in chip form, can be slightly more effective as an adjunct compared to the gel group in enhancing clinical outcomes and contributing to improved periodontal health. Further long-term studies with larger sample sizes are recommended to validate these findings and assess the sustained effects of curcumin delivery systems in periodontal therapy.

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