***Original Research Article***

# A Comparative Evaluation between the efficacy of Scaling & Root Planing (SRP) with Local Delivery of Chlorhexidine Gluconate and SRP alone in Periodontal Pocket Reduction Therapy.



**ABSTRACT:**

**Aim:** The aim of the present study was to compare the efficacy of locally delivered chlorhexidine as an adjunct to scaling and root planning (SRP) & SRP alone in bringing reduction of pocket depth in the treatment of moderate to severe periodontitis patients.

**Materials and Methods:** A total number of 15 patients both males and females in the age group of 30-55 years were selected with total number of 30 sites with periodontal probing pocket depth measuring 5-8mm in different quadrant of the mouth. A randomized, double blind, controlled clinical trial design was followed for the study. On one side scaling and root planning was done and on the other side scaling and root planning was done along with local delivery of chlorhexidine glugocate then the patient was examined after 0, 45, and 60 days using The clinical parameters the Plaque Index (PI), gingival index (GI), Bleeding on probing (BOP), Clinical attachment level (CAL) and Probing pocket depth (PPD).

**Statistical Analysis:** Student paired T-test has been carried out for this present study.

**Results:** The mean reduction of Plaque Index score between 0-45 day between control site and test site was 1.58±0.11 and the mean reduction of Plaque Index score between 0-60 day between control site and test site was 2.42±0.34 which is found not significant. At the Control site the

mean plaque index score on 0 day was 2.2, on 45th day was 1.88 and on 60th day was 1.82. At the test site the mean plaque index score on 0 day was 2.6, on 45th day was 1.82 and on 60thday was 1.59. There was change from the base line values of mean plaque index between the control sites and test sites but was not significant.

**Conclusion:** There was improvement in all the clinical parameters of the test sites in comparison to the control sites from base line to 60 days, but the adjunctive use of chlorhexidine showed a significant improvement only on the clinical attachment level.

**Keyword:** Periodontitis, Gingiva, Periodontal Disease

## INTRODUCTION:

Successful periodontal treatment depends upon marked reduction or elimination of pathogenic micro-organisms in sub gingival sites. Destructive periodontal disease is associated with a variety of microbial species, including the major pathogens *Actinobacillus actinomycetemcomitans, Porphyromonas gingivalis* and *Bacteriodes forsythus* , and some putative pathogens including *Dialister pneumaosintes* , *Prevotella intermedia*, *Campylobacter rectur* , Fusobacterium nucleatum, and various gram-negative enteric rods, pseudomonas , enterococci, staphylococci and yeasts. Efficacy of periodontal treatment may be assessed by its ability to control these micro-organisms. Mechanical root debridement, to remove dental calculus is important in periodontal therapy but is frequently inadequate in curing severe periodontal infections.[1]

Rolla, Loe and Rindom Schiott in 1970[2] had suggested that chlorhexidine, in addition to its antibacterial effect react specifically with organic and inorganic components in and on the surface of the tooth thereby enhancing the topical use of the antibacterial agent.

It had been clearly shown that the bacterial flora of the gingival crevice is important in the etiology of periodontal disease (Loe, Theilade & Jensen 1965, Socransky 1977, Slots 1979)[3, 4, 5] and thus the treatment of the disease is directed to control this flora. The most widely used approach till date has been mechanical methods of cleaning the oral cavity. Antibacterial agents such as chlorhexidine and quaternary ammonium salts in the form of mouth rinses have proved

to be successful in prevention of disease. Goodson et al 1979[6], proposed the use of a device that could be placed within the pockets which would provide a sustained release of antibacterial agents to control the pocket flora.

Systemic antibiotics, on the other hand, necessitate the administration of massive doses in order to achieve adequate concentration at the site of infection, and they come with the risk of bacterial tolerance, drug interactions, and inconsistent patient compliance (Purucker, et al in 2001)[7], one of the most effective topical agents reported till date may be chlorhexidine , which have long been used as an effective antimicrobial therapy for the treatment of gingivitis , however it is generally poorly effective in the treatment of periodontitis. Probably due to its failure to achieve proper biologically meaningful drug concentrations over a long period of time within the periodontal pockets.[8]

A biodegradable chip for the controlled delivery of chlorhexidine directly to the periodontal pocket had been developed by Aubrey Soskolne et al in 1997[9]. In its present formulation the chip biodegrades and release chlorhexidine within the pocket for over 7 to 10 days, maintaining an average concentration of chlorhexidine in the gingival crevicular fluid, greater than 125ug/ml for 8 days (Azmak et al 2002)[10]. A previous report has indicated that, at a concentration of 125ug/ml chlorhexidine, the mean percentage of sub gingival bacteria inhibited in vitro was 99%. Because it is biodegradable, the chlorhexidine chip need not be removed. Reports conducted with a prototype , non-biodegradable chlorhexidine controlled-release local delivery system have indicated that the adjunctive use of chlorhexidine administered in this fashion is effective in reducing probing depth , clinical attachment levels, and bleeding on probing compared with scaling and root planning alone in patients for as long as 2 years (Soskolne et al 2003)[11]. Additionally, the sub gingival bacterial flora were markedly suppressed, effect of which were evident up to 11 weeks after administration. The chlorhexidine chip was also found (Soskone et al 1997)[9] to be similarly effective as an adjunct to scaling and root planning in large, multi-center clinical trials conducted in Europe and Israel.

## AIMS AND OBJECTIVES

The aim of the present study was to compare the efficacy of locally delivered chlorhexidine as an adjunct to scaling and root planning alone in bringing reduction of pocket depth.

The objective of the study was to reduce surgical intervention in treatment of periodontal pocket and to use locally available material so as to reduce the financial burden on the patient and thereby making cost effective management.

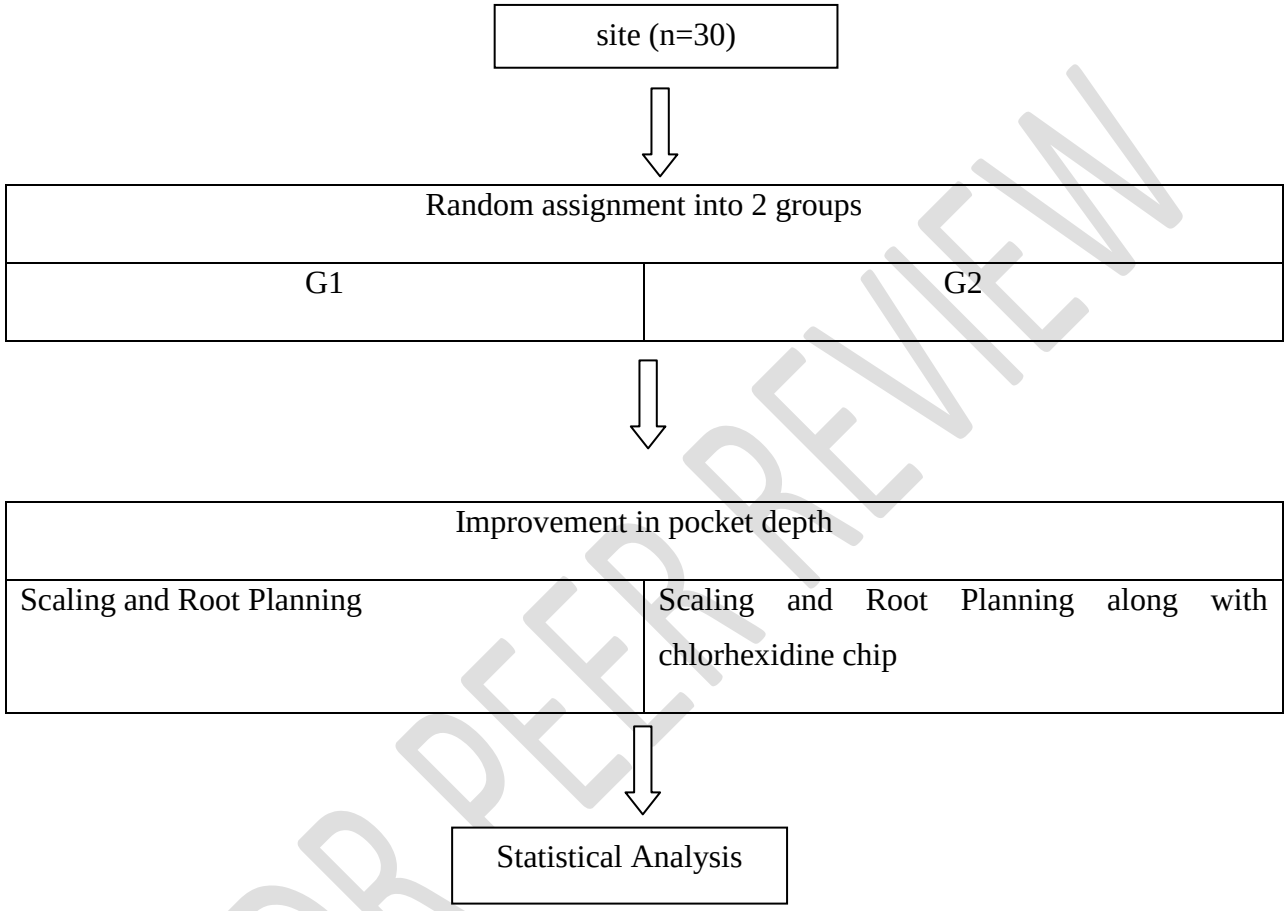


**Fig 1- A (Periocol - CG)**

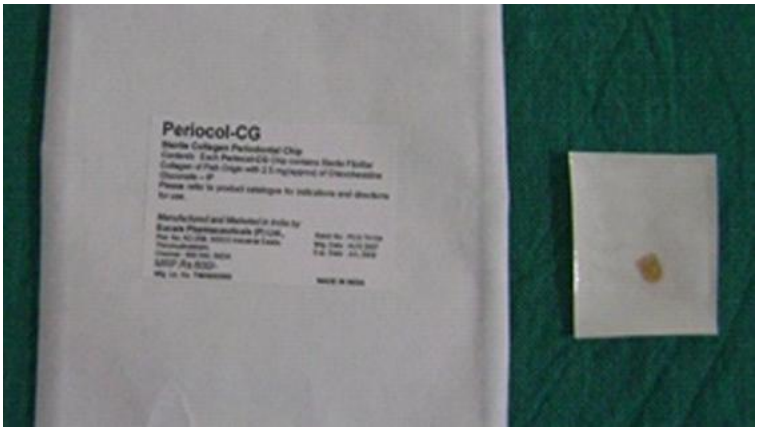
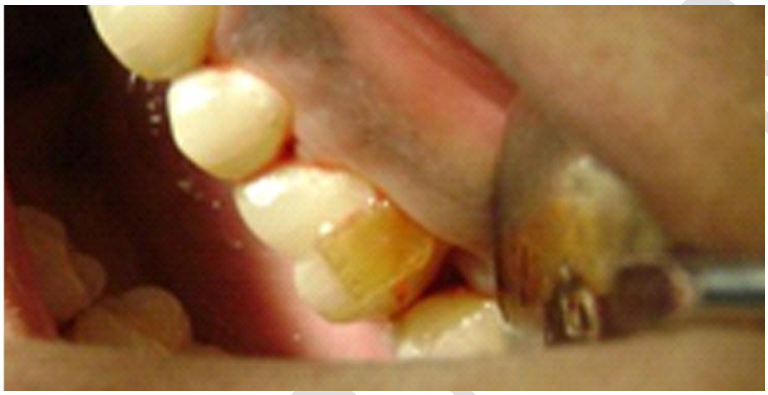



**Fig. 1 – B (placement of chlorhexidine chip "Periocol - CG" in gingival sulcus as controlled release method for chlorhexidine gluconate)**



## MATERIALS AND METHODS:

### Materials:

1. Periocol-CG containing chlorhexidine gluconate and collagen.
2. 15 (8 males and 7 females) patients of age 30-55 years with adult periodontitis having pocket depth of 5-8mm.
3. Sterile curettes.
4. Periodontal probe.
5. Scaling and root planning instruments.

### Methods:

This Randomised Control Trial study was conducted in Department of Periodontology, Kalinga Institute of Dental Sciences, Bhubaneswar, Ethical approval was obtained from institutional review board of the Kalinga Institute of Dental Sciences.

Adults in between age group 30-55 years, patient having periodonitis with a pocket dept of 5-8mm. Subjects willing to participate in the study and who will be present during the study were included. Subjects with systemic disease, and subjects with uncontrolled systemic diseases and are not willing to participate in study were excluded.

A total number of 15 patients both males and females in the age group of 30-55 years who were eligible for the study were selected randomly from the outpatient department of Periodontics and Oral Implantology. A total number of 30 sites from 15 patients with periodontal pocket measuring 5-8mm in different quadrant of the mouth were selected.

A randomized, double blind, controlled clinical trial design was followed for the study. The patient was checked before prophylactic measure for any probing depth, bleeding on probing and clinical attachment level. On one side scaling and root planing was done and on the other side scaling and root planing will be performed and Periocol-cg was placed in the pocket with the

help of a tweezer. Then the patient was examined after 0, 45, and 60 days respectively. (Fig. no. 1 A & 1 B)

Parameters checked:

1. Plaque index.
2. Gingival index.
3. Sulcular bleeding index.
4. Probing pocket depth.
5. Clinical attachment level.

Plaque index (Sillness & Loe 1967) and Gingival index (Loe & Sillness 1967)[12] were recorded as follows.

Soft tissue parameters:

Soft tissue changes were evaluated by measuring probing attachment level, reduction in probing pocket depth and gingival recession. The measurements were taken using Williams periodontal probe (marking at 1, 2, 3, 5, 7, 8, 9, 10)

Following measurements were recorded

1. RP (reference point) to GM (Gingival margin)

2. RP (reference point) to CEJ (cementoenamel junction)

3. RP (reference point) to BOP (Base of pocket)

Pocket depth was recorded pre-operative by noting the difference between measurements from the reference point to the base[13].

PD (pocket depth) = RP to BOP- RP to GM

Probing attachment level was calculated by subtracting the distance between reference point to cemento-enamel junction and from distance between reference points to base of the pocket.

PAL= RP to BOP- RP to CEJ

Patient preparation:

The patient was made to sit comfortably on the dental chair and pocket depth was measured with help of probe and stent. The tooth of two sites with pocket depth of 5mm or more were selected. Then scaling and root planing on both the sites was done. Then site for insertion of chlorhexidine chip was selected randomly. Gingival retraction cord was used retract the gingival sulcus &to mount the chip, which was then sealed with cyanoacrylate. This site was named as *"test site"* and the site without chip was named as *"control site".*

Clinical Parameters:

All clinical parameters which were Plaque Index, Gingival Index, Sulcular Bleeding Index, Clinical Attachment Level and Pocket Depth were recorded on 0 day then on $45^{th}$ days and finally on $60^{th}$ day for statistical analysis.

**STATISTICAL ANALYSIS:**

The values for all the recorded Clinical parameters were assessed and analyzed by using the following statistical test and formulae. Student paired t-test was employed to test the significance of mean changes at different time intervals within the group.

**RESULTS:**

This clinical study evaluates the efficacy of chlorhexidine chip as an adjunct to Scaling and root planing in the treatment of pocket depth of 5mm or more. Total number of patients evaluated were 15; control site and test site were evaluated at 0 days then on $45^{th}$day and finally on $60^{th}$day. In the control site only scaling and root planing was done and on test site scaling and root planing with chlorhexidine chip insertion was done. All 30 sites treated appeared to be free from clinically detectable inflammation in $45^{th}$ and $60^{th}$ day after treatment, indicating that the

materials used were well tolerated. After 45days and 60days all measurements was taken and results were evaluated by using Student-paired t-test.

The mean reduction of Plaque Index score between 0-45 days between control site and test site was 1.58±0.11 and the mean reduction of Plaque Index score between 0-60 days between control site and test site was 2.42±0.34 which is found not significant. At the Control site the mean plaque index score on the 0,45$^{th}$ and 60$^{th}$ day were 2.2, 1.88 and 1.82 respectively. At the Test site the mean plaque index score on 0,45$^{th}$ and 60$^{th}$ were 2.6, 1.82 and 1.59 respectively. There was change from the base line values of mean plaque index between the control sites and test sites but was not significant; however there was a minor change when chlorhexidine chip was used as an adjunct to scaling and root planing alone. (Table-1)

**Table 1:-** Comparison of mean plaque index scores and percentage changes within control site and test site at different time points

| | Control site | | | | Test site | | | |
|---|---|---|---|---|---|---|---|---|
| Time | Mean ± SD | Changes From Baseline | % change | Significance | Mean ± SD | Changes From Baseline | % change | significance |
| 0 Day | 2.2 ± 0.30 | | | | 2.5 | | | |
| 45$^{th}$ Day | 1.8 ± 0.46 | 0.4 | 18.1% | 2.25 | 1.8 ± 0.2 | 0.7 | 28% | 7.56 |
| 60$^{th}$ Day | 1.8 ± 0.7 | 0.4 | 18.1% | 1.97 | 1.6 ± 0.35 | 0.9 | 36% | 6.4 |

*Student paired t-test*

The mean reduction of Gingival Index score between 0-45 days between control site and test site was 3.24±0.1 and the mean reduction of Gingival Index score between 0-60 days between

control site and test site was 5.24±0.11 which is found not significant. There was change in base line values of mean gingival index between control sites and test sites but was not significant. This signifies that there is a minor change when chlorhexidine chip was used as an adjunct to scaling and root planning alone. (Table-2)

**Table 2:-**Comparison of mean gingival index scores and percentage changes within site, control site and test site at different time points

| | Control site | | | | Test site | | | |
|---|---|---|---|---|---|---|---|---|
| Time | Mean ± SD | Changes From Baseline | % change | Significance | Mean ± SD | Changes From Baseline | % change | significance |
| 0 Day | 2.0 | | | | 2.3 | | | |
| 45th Day | 1.85 ± 0.35 | 0.15 | 7.5 | 4.35 | 1.75 ± 0.31 | 0.55 | 23 | 5.69 |
| 60th Day | 1.71 ± 0.39 | 0.29 | 12.5 | 4.88 | 1.6 ± 0.41 | 0.7 | 30 | 7.7 |

*Student paired t-test*

The mean reduction of Sulcular Bleeding Index score between 0-45 day between control site and test site was 2.84±0.19 and the mean reduction of Sulcular Bleeding Index score between 0-60 day between control site and test site was 3.24±0.3 which was not statistically significant. These values show that there was change in the base line values of mean sulcular bleeding index between control sites and test sites; however there was only little significant change in the t-value test. This signifies that there is a minor change when chlorhexidine chip was used as an adjunct to scaling and root planing alone. **(Table-3)**

**Table 3:-** Comparison of mean sulcular bleeding index scores and percentage changes within site, control site and test site at different time points

| | Control site | | | | Test site | | | |
|---|---|---|---|---|---|---|---|---|
| Time | Mean ± SD | Changes From Baseline | % change | Significance | Mean ± SD | Changes From Baseline | % change | Significance |
| 0 Day | 3.7 | | | | 3.9 | | | |
| 45th Day | 2.93 ± 0.5 | 0.77 | 20.8 | 5.2 | 2.78 ± 0.6 | 1.1 | 28.2 | 5.76 |
| 60th Day | 2.92 ± 0.48 | 0.78 | 21.0 | 6.48 | 2.3 ± 0.9 | 1.6 | 41.0 | 4.4 |

*Student paired t-test*

The mean reduction of Periodontal pocket depth score between 0-45 day between control site and test site was 2.55±0.19 and the mean reduction of Periodontal pocket depth score between 0-60 day between control site and test site was 3.6±0.19 which was not statistically significant. There was change from the base line values of mean probing depth between control site and test site; however there was no significant change in the t-value test. This signifies that there is a minor change when chlorhexidine chip was used as an adjunct to scaling and root planning alone. (Table-4)

**Table 4:-**Comparison of mean periodontal pocket depth scores and percentage changes within site, control site and test site at different time points and its significance.

| | Control site | | | | Test site | | | |
|---|---|---|---|---|---|---|---|---|
| Time | Mean ± SD | Changes From Baseline | % change | Significance | Mean ± SD | Changes From Baseline | % change | Significance |
| 0 Day | 5.8 | | | | 5.8 | | | |
| 45th Day | 5.18 ± 0.64 | 0.62 | 10.7 | 4.54 | 5.05 ± 0.6 | 0.75 | 12.9 | 5.1 |
| 60th Day | 4.97 ± 0.51 | 1.03 | 17.7 | 6.5 | 4.77 ± 0.68 | 1.13 | 19.4 | 5.6 |

*Student paired t-test*

The mean reduction of Clinical attachment level score between 0-45 day between control site and test site was 3.06±0.2 and the mean reduction of Clinical attachment level score between0-60 day between control site and test site was 4.95±0.24 which was not statistically significant. There was change from the base line values of mean clinical attachment levels between control site and test site and there was slightly significant change in the t-value test. This signifies that there was a minor change when chlorhexidine chip was used as an adjunct to scaling and root planning alone. (Table-5)

**Table 5:-**Comparison of mean clinical attachment level scores and percentage changes within site, control site and test site at different time points and its significance.

| | Control site | | | | Test site | | | |
|---|---|---|---|---|---|---|---|---|
| Time | Mean ± SD | Changes From Baseline | % change | Significance | Mean ± SD | Changes From Baseline | % change | Significance |
| 0 Day | 7.4 | | | | 7.4 | | | |
| 45th Day | 7.17 ± 0.65 | 0.23 | 3.1 | 4.25 | 7.0 ± 0.65 | 0.4 | 5.4 | 4.7 |
| 60th Day | 6.49 ± 0.5 | 0.91 | 12.3 | 4.8 | 6.2 ± 1.1 | 1.2 | 16.2 | 2.8 |

*Student paired t-test*

**DISCUSSION:**

Over the last two to three decades, periodontal research has brought dramatic changes in the understanding of periodontitis.[14]

After the establishment of a causal link between bacterial plaque accumulation and inflammatory changes in the marginal periodontium (Loe et al 1965)[3], several links of evidence gained between the late 70s and early 90s have led to the establishment of the bacterial etiology of periodontitis.[15] Many investigations have assessed the possibility of using anti-microbial as a therapy for periodontal infections.As evidence for the infectious etiology of periodontitis was emerging, profound changes were happening in the pharmaceutical technology to optimize delivery of drugs at their sites of action.[16] Significant decrease in bleeding on probing and in probing pocket depth, and increase in probing attachment levels, has been reported on controlled clinical trials.[17]

Based on these findings the present study was done. Chlorhexidine gluconate is an antimicrobial agent and is active against a broad spectrum of microbes.[18] The chlorhexidine molecule, due to its positive changes, react with microbial cell surface, destroys the integrity of the cell

membrane, penetrates into the cell, precipitate the cytoplasm leading to cell death.. This consequently leads to improvement of gingival and periodontal health.[19] PERIOCOL-CG is a small, orange-brown rectangular chip form rounded at one end for easy insertion into periodontal pockets. Each Periocol-CG contains approximately 2.5mg of chlorhexidine gluconate in a biodegradable matrix of Type 1 collagen derived from fish sources.[20] It is Gamma sterilized and supplied in individual aluminum blister packing. Periocol-CG releases chlorhexidine in vitro with a release profile of approximately 40-45% within 24 hours and thereon in a linear fashion for 7-8 days. The release profile may be explained as initial burst effect, due to diffusion of the drug from the chip followed by release of the drug due to enzymatic degradation.[21]

In the control site the mean difference of Plaque Index between 0-45 days was 0.4±0.46 with a 18.1% percentage of reduction and between 0-60 days was 0.4±0.7 with a percentage of reduction of18.1% both of which was not significant.In the test site the mean difference of Plaque Index between 0-45 days was 0.7±0.2 with 28% percentage of reduction and between 0-60 days was 0.9±0.35 with a percentage of reduction of 36% both of which was not significant.This was in accordance with the findings of Soskolne W.A et al (1997)[9] whom in a clinical study evaluated the efficacy of a subgingival delivery system containing 2.5 mg chlorhexidine in a randomized, blind multicenter study of 118 patients with moderate periodontitis. A split mouth design was used to compare a treatment outcome of scaling and root planning alone or with the combined use of SRP and chlorhexidine in pocket with probing depth of 5-8 mm.

Ayala Stabholz et al (1991)[22] also had found that the mean plaque index at the site receiving chlorhexidine treatment showed no significant difference from that at sites receiving regular maintenance therapy at the commencement of the study (0.35±0.09 and 0.54±0.20 respectively). There was a distinct increase in the plaque index during the first 3 to 6 months following both treatments, after which it levels out until the end of the study. There are no significant differences in the change in plaque index from baseline between the 2 treatment groups at any of the examination periods.

Majorie K.Jet al 1998[23] in their study had also found that the mean plaque index was about 1.2 at baseline and was reduced 0.01 to 0.17 from baseline during the study and was not significant. The reason for this absence of significant reduction in plaque index level may be due to the

presence of the cyanoacrylate dressing given in the test site which might have hindered thorough mechanical plaque control measures by the patients.

The mean difference of Gingival Index in the control site between 0-45 days was 0.15±0.35 with a percentage of reduction of 7.5percent and between 0-60 days was 0.29±0.39 with a percentage of reduction of 12.5% both of which was not significant.

At the test site between 0-45 day was 0.55±0.31 with a percentage of reduction of 23% and between 0-60 days was 0.7±0.41 with 30% percentage of reduction both of which was not significant.Majorie K.J et al 1998[23] in their study had also found that there were no clinically significant changes in the gingival index. At baseline, the mean gingival index ranged from 1.50-1.57; reduction from baseline for the duration of the study ranged from 0.22-0.33 which was not clinically significant.

The reason for the absence of significant reduction in the mean gingival index may be attributed to the fact that the presence of cyanoacrylate dressing given in the test site might have hindered thorough mechanical plaque control measures by the patients.

The mean difference of Sulcular Bleeding Index in the control site between 0-45 days was 0.77±0.5 and the percentage of reduction was 20.8% and the mean difference of Sulcular Bleeding Index between 0-60 days was 0.78±0.48 and the percentage of reduction was 6.48% which was not significant.The mean difference of Sulcular Bleeding Index in the test sites between 0-45 days was 1.1±0.6 and the percentage of reduction was 28.2% and the mean difference of Sulcular Bleeding Index between 0-60 days was 1.6±0.9 and the percentage of reduction was 41.0% which was not statistically significant.[24]

The results of our study is in agreement with the findings of Majorie K.Jet al 1998[23] who had reported a slight trend for reduction of bleeding on probing in the chlorhexidine chip plus scaling and root planning treatment group compared with the 2 control groups. Sulcular bleeding index during the study at baseline was 0.51 to 0.59, and changes during the study ranged from 0.18 to 0.07 which was not significant.

In the control site the mean difference of Periodontal Pocket Depth between 0-45 days was 0.62±0.64 and the percentage of reduction was 10.7% and between 0-60 days was 1.03±0.51 with a percentage of reduction of 17.7% which was not significant.The mean difference of

Periodontal Pocket Depth in the test group between 0-45 days was 0.75±0.6 and the percentage of reduction was 12.9% and between 0-60 days was 1.13±0.68 and the percentage of reduction was 19.4% which was not statistically significant .[24]

The results of our study is in agreement with that of Wilson T.G. et al(1999)[25] who had found significant reduction in probing pocket depth and a gain in clinical attachment level after a study period of 6 months. However, follow up study on the same subjects after a period of 5 years showed a loss of clinical attachment level and increase in probing pocket depth, showing that the significant results obtained initially was transient.

Killoy W.J. et al (1998)[26] comparing scaling and root planing and chlorhexidine chip in periodontal pocket of 5mm or more found a significant improvement in probing pocket depth at 1,3,and 6 months and clinical attachment levels at 6 months.

The mean difference of Clinical Attachment Level in the control site between 0-45 days was 0.23±0.65 and the percentage of reduction was 3.1% and between 0-60 days was 0.91±0.5 and the percentage of reduction was 12.3% which was not statistically significant. The mean difference of Clinical Attachment Level in the test site between 0-45 days was 0.4±0.65 and the percentage of reduction was 5.4% and between 0-60 days was 1.2±1.1 and the percentage of reduction was 16.2% which was slightly significant.

The results of our study is in accordance to the results of that of Wilson T.G. et al(1997)[23] who had found significant reduction in probing pocket depth and a gain in clinical attachment level after a study period of 6 months.

W A Soskolne et al (1997)[9] had also shown that the improvement in the clinical attachment level obtained with chlorhexidine was greater than that obtained by SRP alone at three months.

Killoy W.J. and Polson A.M. (1998)[26] comparing scaling and root planing and chlorhexidine chip in periodontal pocket of 5mm or more found a significant improvement in probing pocket depth at 1,3,and 6 months and clinical attachment levels at 6 months.

In the present study there were significant differences from 0 to 45$^{th}$ and 0 to 60$^{th}$ day in all the clinical parameters in control site and test site but no significant difference between the two treatment sites were found regardless of whether combined antimicrobial mechanical therapy

was performed, except for clinical attachment level which showed slightly significant difference from 0-day to 60th day.

The above findings of the study show that the use of chlorhexidine chip along with scaling and root planning does not offer any significant advantage over scaling and root planning alone, excepting for a marginal benefit of resolution of gingival inflammation and clinical attachment level. This emphasizes the importance of mechanical therapy in the form of subgingival debridement and root planing.[27, 28]

However, the limitation of this study should be borne in mind and further studies with an increased number of sites and a longer follow up period should throw more light on the effect of locally delivered chlorhexidine chip in the treatment of periodontitis.[29]

## CONCLUSION:

The present study was undertaken to compare the adjunctive use of efficacy of chlohexidine to scaling and root planing, and to compare it with scaling and root planing alone in the treatment of chronic periodontitis.The clinical parameters used were Plaque Index, Gingival Index, Sulcular Bleeding Index Probing pocket depth and clinical attachment level. There was difference in plaque index, gingival index, and sulcular bleeding index in both test site and control site at different time points, from baseline to 45days and baseline to 60days.As evident from the present study it can be concluded that there was improvement in all the clinical parameters of the test sites in comparison to the control sites from base line to 60 days, but the adjunctive use of chlorhexidine chip showed a significant improvement only on the clinical attachment level.

Further long term studies are recommended to evaluate the adjunctive use of chlorhexidine and also to compare it with other local drug delivery systems.

## COMPETING INTERESTS DISCLAIMER:

Authors have declared that no competing interests exist. The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of

knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

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