



Comparative evaluation of the plaque inhibitory effects of magnetized water versus Chlorhexidine on *S.mutans* in patients with chronic generalized periodontitis-a randomized clinical study.

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ABSTRACT: This study aimed to assess the efficacy of magnetized water and compare it with 0.2% chlorhexidine gluconate on *S.mutans* as an anti-plaque agent and its effect on gingival inflammation. 80 subjects between 15-50 years with chronic periodontitis were included in the study. They were randomly divided into 2 groups of 40 subjects each. After oral prophylaxis, group 1 and group 2 used Chlorhexidine and magnetized water, respectively, as mouthwashes. The subjects were advised to use 10 ml of mouthwash for 1 min twice a day 30 min after brushing. Parameters are recorded for plaque, gingival, and sulcus bleeding indices at day 0, 7, 14, and 28 days along with the subjective assessment of taste apart from salivary *S.mutans* count. Considering the above findings of our study, it is clear that both the mouthwashes effectively reduce plaque and gingival inflammation in chronic generalized periodontitis patients. Based on our study's observations, it can be concluded that chlorhexidine gluconate and magnetized mouthwash can be effectively used as an adjunct to mechanical plaque control to prevent periodontitis. Both the mouthwashes have comparable anti-plaque, anti-inflammatory and anti-microbial properties. As magnetized water is biocompatible, well accepted by all subjects without any side-effects as with Chlorhexidine.

KEYWORDS: Magnetized water, Mouthwash, Chlorhexidine gluconate, *S.mutans*, Magneto hydrodynamics

I.INTRODUCTION

Primary measures to control oral diseases is to prevent plaque accumulation. The microorganisms in bacterial plaque cause

inflammatory periodontal disease. Thus, plaque control plays a significant role in the prevention of caries, gingivitis, and periodontitis. Both mechanical procedures and local chemotherapeutics (Cummins 1997)⁴ are used for this purpose.

Chlorhexidine gluconate is commonly used as mechanical plaque control adjuvant. Chlorhexidine gluconate, a cationic bis-biguanide, was introduced for human use in 1957 in Great Britain.

Chlorhexidine (0.2%) mouth rinse has also shown antibacterial efficacy. C Rindom, WW Briner and H Loe (1) found a reduction of 30 to 50% in the population of *S. mutans* after rinsing with 10 ml of 0.2% chlorhexidine mouth rinse once daily. Its long-term use has some potential drawbacks like bitter taste, light brown staining of teeth, altered taste sensation and development of resistant microorganisms, oral mucosal erosions and enhanced supragingival calculus formation. This has developed the need for alternatives that can be acceptable, affordable and appropriate as well.

Magnetism is well known in the field of physics. Magnets prove to be a strong safeguard against illness and serve as a highly beneficial preventive device. When water passes through the magnetic field, it undergoes certain changes. The magnetic field alters the electrical characteristics of hydrogen ions as well as minerals. The force of magnetism has a great influence on living organism. When a permanent magnet is kept in continuous contact with water for a considerable time, the water is influenced by the magnet's magnetic flux and becomes magnetized and acquires magnetic properties. Best results are



achieved when water is magnetically treated just prior to use.⁸ Since many researches have been done using magnets in the medical field, its use in dentistry is still lacking.

Magnetized water, which is more alkaline with increased pH, reduces surface tension rendering it much softer. Due to this reduction in surface tension, magnetized water becomes thinner and better penetrates the bacterial cell wall, leading to lysis and an alternative mouth rinse.

II. AIMS AND OBJECTIVES:

1. To evaluate and compare antibacterial efficacy of commercially available 0.2% chlorhexidine mouth rinse and conventionally prepared magnetized water on *S. mutans*.
2. To compare and evaluate plaque, gingival, and sulcus bleeding indices of use of 0.2% chlorhexidine mouth rinse and magnetized water along with their taste acceptance.

III. MATERIALS AND METHODS:

This study was conducted in 2018-2019 at Lenora Institute of Dental Sciences and Hospital, Rajanagaram, Andhrapradesh.

SELECTION CRITERIA:

80 subjects between 15-50 years with chronic gingivitis and periodontitis were included in the study. The study was conducted for a period of 28 days.

Selection criteria:

- Systemically healthy patients
- No fixed or removable orthodontic appliances or removable prosthesis
- No history of antibiotic therapy in the subjects within the previous 3 months
- No use of chlorhexidine mouth wash or magnetized water as oral rinse earlier
- No history of oral prophylaxis done for at least 3 months prior to the study.

After selection, oral prophylaxis of all the subjects was done using an ultrasonic scaler. Then the subjects were instructed to abstain from any oral hygiene measures for the next 24 hours.

A baseline saliva sample was collected using a spitting method in a sterile sample collecting bottles for all the subjects.

They were randomly divided into 2 groups of 40 subjects each. After oral prophylaxis, group 1 and group 2 used Chlorhexidine and magnetized water as mouthwashes after 24 hrs

After collecting baseline samples, the

subjects were given the respective mouth rinse as per the groups and were asked to rinse as instructed under supervision. The saliva sample was again collected.

The subjects were advised to use 10 ml of mouthwash for 1 min twice a day 30 min after brushing. Parameters were recorded for plaque, gingival, and sulcus bleeding indices at day 0, 7, 14, and 28 days along with a subjective assessment of taste.

The subjects were then asked to start maintaining their oral hygiene as regular. The same procedure was repeated on day 1 evening.

After 7 days, the same procedure was followed for all the groups under the supervision, and the sample collection was done under aseptic conditions.

IV. METHOD OF MAGNETIZING WATER

RO water was taken in glass bottles and was kept over the magnets for 72 hours for magnetization. It was sent to JNTU physics laboratory, Kakinada, to check for pH and electrical conductivity, which were reported as follows:

Type of water	pH	Electrical conductivity
RO water—normal	7.2	25.1
Magnetized water—72 hours	7.98	11

DAYS OF SAMPLE COLLECTION

For Saliva

Day 1—baseline, morning and evening

Day 7—morning and evening.

The samples were collected in sterile sample bottles to check for the *S. mutans* count. They were carried in the icebox containing ice (as transport media) to the microbiology laboratory, where the culture plates were inoculated for the *S. mutans* count.

MUTANS SANGUIS AGAR: HIMEDIA

This agar is recommended for the differentiation of *S. mutans* and *S. sanguis* associated with oral microflora. *S. mutans* forms rough, heaped, irregular colonies resembling frosted glass. Mostly crumbly, white, grey or yellow and 0.5 and 2 mm in diameter.



V. RESULTS

Table 1 shows the mean and standard deviation values at various levels of all the groups. Tables 2

show a student t-test to compare the differences at various levels of all the groups.

Table 1: Mean and standard deviation values of *S. mutans* (in cfu/ml) at various levels of groups I, II

Groups	Levels					
	Base line	1st day morning	1st day evening	4th day evening	7th day morning	7th day evening
Group I	140.25 ± 48.02	2.75 ± 10.86	00.00 ± 00.00	00.00 ± 00.00	00.00 ± 00.00	00.00 ± 00.00
Group II	160.00 ± 43.59	160.00 ± 43.59	97.50 ± 30.52	65.00 ± 16.58	39.00 ± 16.25	30.00 ± 10.00

Table 2: Statistical comparison (by unpaired t-test) of *S. mutans* (in cfu/ml) of mean change at various levels between groups I and II

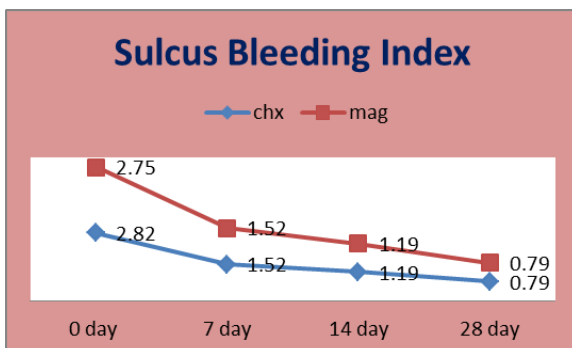
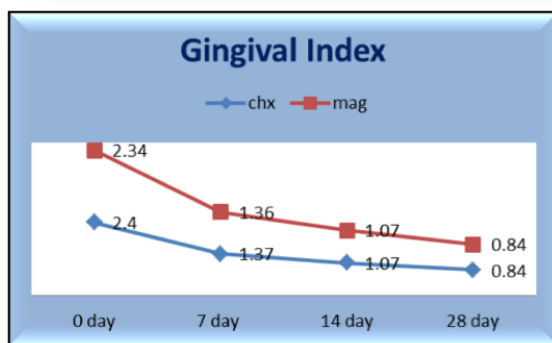
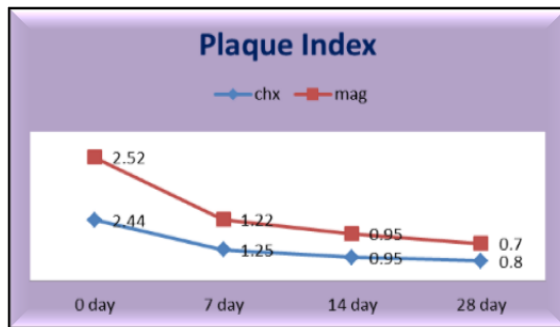
Groups	Levels				
	1st day morning	1st day evening	4th day evening	7th day morning	7th day evening
Group I	137.50 ± 53.70	140.25 ± 49.27	140.25 ± 49.27	140.25 ± 49.27	140.25 ± 49.27
Group II	0.00 ± 0.00	62.50 ± 37.73	95.00 ± 36.89	121.00 ± 43.38	130.00 ± 42.16
p-value	< 0.001	< 0.001	< 0.001	< 0.001	> 0.05
Significance	HS	HS	HS	HS	NS

HS – highly significant, NS – not significant

Table 3: Pair-wise comparisons (p-value) of Gingival Index and Plaque Index between different time periods.

Groups	Time period	Levels		
		Plaque index	Gingival index	Sulcus bleeding index
Group I	0 days	2.44	2.4	2.82
	7 days	1.25	1.37	1.52
	14 days	0.95	1.07	1.19
	28 days	0.8	0.84	0.79
Group II	0 days	2.52	2.34	2.75
	7 days	1.22	1.36	1.52
	14 days	0.95	1.07	1.19
	28 days	0.7	0.84	0.79
p-value	< 0.001	< 0.001	< 0.001	< 0.001
Significance	HS	HS	HS	HS

HS – highly significant, NS – not significant



The mean baseline scores of PI & GI were similar for all the 3 groups. Tests of within-subjects for PI for the 3 groups showed a p value<0.005. Thus, the differences in the mean PI for all the 3 groups were significant. On day 14, when compared with the baseline data was made, there was no significant difference in the mean PI scores of magnetized water and Chlorhexidine groups (p=0.018 and p=0.016, respectively). On day 21, no significant difference in the mean PI scores was observed when compared with that of magnetized water and Chlorhexidine groups (p<0.001 and p<0.001, respectively). Thus, Magnetized water and chlorhexidine groups had less plaque accumulations. There were significant differences in the mean plaque accumulations between the

magnetized water and chlorhexidine group on examination on the 14th and 21st days (p<0.05). Tests of within-subjects effects for GI for the 3 groups showed a p-value <0.05. Thus, the differences in mean GI for all the 3 groups were significant. On day 14, compared with the baseline data, there was a significant decrease in the mean GI scores of magnetized water and chlorhexidine groups. (p=0.018 and p=0.018 respectively). Unlike the PI score, there was no significant difference in the GI between the magnetized water and the chlorhexidine group (p>0.05).[Figure3]

VI. DISCUSSION:

Microorganisms constantly colonize the surface of the oral cavity. One millilitre of the whole saliva may contain more than 200 million organisms representing more than 250 different species.

Streptococcus constitutes an essential part of the microflora, which constantly colonize the mucous membrane and the teeth. The streptococci in the oral cavity comprise *S. sanguis*, *S. mitis*, *S. salivarius*, *S. intermedius* and other streptococci, of which *S. mutans* and *S. sobrinus* are maximum.

S. mutans is a gram-positive, facultative anaerobic bacteria commonly found in the human oral cavity and is a significant contributor to tooth decay.

In the present study, the daily use of Chlorhexidine twice reduces the salivary *S. mutans* count highly significantly when comparing baseline with all sample levels used for earlier studies.

- Chlorhexidine, regarded as the gold standard, has certain side effects and are also cost-effective. Hence this study was planned with RO treated water for magnetization to test its anti-plaque and anti-inflammatory properties in gingivitis patients.
- Chlorhexidine gluconate 2% mouthwash showed a statistically significant (p<0.05) reduction in mean PI, GI and SBI at 0,7,14,28 days from baseline, similar to studies done by Loe et al. (1970)¹ and Sekino S et al. (2003)⁷. Vander Weijden et al. (1998), Grundemann et al. (2002)⁵, Leyes et al. (2002)⁶ studies showed a significant reduction of gingival inflammation, which coincides with the findings in this study.
- Magnetized water group also showed a large reduction from baseline values of plaque index 2.52 ± 0.59 to 1.22 ± 0.62 , 0.95 ± 0.72 and 0.7 ± 0.58 after 7, 14 and 28 days, respectively. Similar plaque reduction is observed in a



previously done study by Gupta and Bhat (2008)⁹. This reduction in PI can be explained by Hibben SO (1973)² "Magneto hydrodynamics", which stated prevention of naturally occurring mineral deposits in fluids, changing from liquid to a solid-state, by which plaque, calculus adherence and accumulation on teeth is inhibited.

- The magnetized group baseline gingival scores was 2.34 ± 0.52 , which reduced to 1.36 ± 0.47 , 1.07 ± 0.63 and 0.84 ± 0.57 after 7, 14 and 28 days, respectively. Reduction is seen with the sulcus bleeding index scores from the baseline value of 2.75 ± 0.42 to 1.52 ± 0.49 , 1.19 ± 0.41 and 0.79 ± 0.36 after 7, 14 and 28 days, respectively, which is statistically significant ($p < 0.05$). This reduced gingival inflammation can be explained with Wevangti Vange (2008) "Water Ionization" stopping the free radical cycle. Although PI, GI and SBI scores significantly decreased in both groups at 7, 14 and 28 days follow up, inter group comparison did not reveal statistically significant difference ($p > 0.05$)
- Since magnetized water is alkaline and also as *S. mutans* is anaerobic bacteria, therefore, its alkaline property stops the anaerobic bacteria to grow, thereby reducing the count
- Taking into consideration of all the findings of our study, it is clear that both the mouthwashes are effective in reducing plaque and gingival inflammation in chronic generalized periodontitis patients, but the present study results demonstrate that group I shows more reduction in *S. mutans* count than group II
- Reduction in mean plaque gingival and sulcus bleeding index was observed from 0 to 28 day in both groups.
- Magnetized water rinse was acceptable in taste and was biocompatible. It has been observed in the present study from subjective and objective criteria that bitter taste was experienced by 13 subjects using chlorhexidine mouthwash.
- Thus, our study results show that the magnetized mouthwash is free of the side effects of bitter taste and staining, which occurred with the chlorhexidine mouthwash.
- Magnetized water inhibits the bonding process by which bacteria colonize and by which plaque attaches to teeth.
- The inhibition can be attributed to the principle of magneto hydrodynamics, which prevents the naturally occurring mineral deposits in fluids,

changing from liquid to a solid-state. This occurs by interruption of the normal process of colonization (electrovalent bonding of cations) and therefore prevents the formation of deposits that would otherwise adhere to a host surface. By this principle, the bonding process by which bacteria colonizes and by which plaque and calculus adhere and accumulates on teeth is inhibited.

- In our study, chx mouthwash showed a significant reduction in mean PI, GI and SBI at 0, 7, 14, 28 days from baseline, similar to the study done by Loe et al (1970)¹ and Sekino S et al (2003)⁷.
- Magnetized water group baseline values of plaque index was 2.52 ± 0.59 , which reduced after rinsing with magnetized water to 1.22 ± 0.62 , 0.95 ± 0.72 and 0.7 ± 0.58 after 7, 14 and 28 days, respectively, which are consistent in a previously done study by Gupta and Bhat⁸. This is due to Hibben SO⁹ "Magneto hydrodynamics", which prevents naturally occurring mineral deposits in fluids, changing from liquid to a solid-state, by which plaque & calculus adherence & accumulation on teeth is inhibited
- The magnetized group baseline gingival scores was 2.34 ± 0.52 , which reduced to 1.36 ± 0.47 , 1.07 ± 0.63 and 0.84 ± 0.57 after 7, 14 and 28 days, respectively. Similar reduction is seen with the sulcus bleeding index scores from the baseline value of 2.75 ± 0.42 to 1.52 ± 0.49 , 1.19 ± 0.41 and 0.79 ± 0.36 after 7, 14 and 28 days, respectively, which is statistically significant ($p < 0.05$). This reduced gingival inflammation can be explained with Wevangti Vange (2008) "Water Ionization" stopping the free radical cycle. Although PI, GI and SBI scores significantly decreased in both groups at 7, 14 and 28 days follow up, inter group comparison did not reveal statistical significant difference ($p > 0.05$)
- Considering all the findings of our study, it is clear that both the mouthwashes effectively reduce plaque and gingival inflammation in chronic generalized periodontitis patients.

VII. CONCLUSION:

Based on our study's observations, it can be concluded that chlorhexidine gluconate and magnetized mouthwash can be effectively used as an adjunct to mechanical plaque control to prevent plaque gingivitis.

When comparing the antibacterial efficacy, Chlorhexidine has shown a better



reduction in *S. mutans* count than magnetized water. Magnetized water has also shown a reduction in *S. mutans* count, and therefore, it can be used as an alternative to Chlorhexidine

Both the mouthwashes have comparable anti-plaque, anti-inflammatory and anti-microbial properties. Magnetized water is biocompatible, well accepted by all subjects without any side effects. For antibacterial effects and, therefore, can be used as an alternative measure to Chlorhexidine.

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