ORIGINAL RESEARCH

Evaluation of the Antimicrobial Activity of Magnetized Water and Its Comparison with Chlorhexidine 0.2% in Young Children for 3 Weeks

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Abstract

Aim: The goal of this study was to compare the effects of magnetized water and 0.2% chlorhexidine mouthwash on gingivitis and plaque prevention in children aged 12–15 years for a period of 21 days.

Materials and methods: A total of 24 youngsters between the ages of 12 and 15 years were chosen. A computer-generated random number sequence was used to split the research participants into two groups. Magnetized water was utilized as a mouthrinse in Category 1, while 0.2% chlorhexidine was employed in Category 2. Water purified with reverse osmosis was stored in glass bottles, which were then put near the magnets to create magnetic water. The magnets had 1000 Gauss power. The bottles were put for a period of 24 hours. The youngsters were given 140 mL of mouthrinse. These mouthrinses were to be used at home, they were told. The Gilmore Turesky adaptation of Quigley Hein's plaque index was used to assess the plaque whereas the gingival index recommended by Loe and Sillness was utilized to assess the gingiva. The plaque index and gingival index were analyzed at baseline, 14 days, and 21 days, as well as history and examination for adverse effects such as bitter taste, brownish discoloration, and so on, were recorded. The trial lasted 21 days with a follow-up period of another 21 days.

Results: Both magnetic water and chlorhexidine were similarly successful in managing periodontal and gingival infections; however, magnetized water had less side effects, such as a bitter metallic taste and brown stains.

Conclusion: Because of its well-accepted flavor, softer nature, and lower frequency of brown stains, magnetized water can be a safer and more acceptable alternative to chlorhexidine mouthwashes, especially in youngsters.

Clinical significance: The use of chlorhexidine as a mouthrinse in the oral cavity has been linked to side effects. These side effects are mostly localized, such as brownish discoloration of teeth, alterations in taste perception, and erosion of the oral mucosa. As chlorhexidine has such negative side effects, it was necessary to do research, particularly in children, to identify a replacement that is similarly efficient against germs but does not have these side effects. Water treated with a magnetic field (magnetized water) was compared with chlorhexidine in the current study.

Keywords: Children, Chlorhexidine, Magnetized water.

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Introduction

The oral cavity's health is thought to have a significant impact on an individual's overall health as well as the quality of life. There are various oral diseases that are frequent. Periodontal disease is one of the most frequent diseases. Gingivitis, which is produced by biofilm on the teeth surface, is the most frequent periodontal disease. Ninety percent of the population is affected by it. These diseases are thought to affect people of all ages, ethnicities, and genders equally. This sickness is also a prevalent affliction among children. According to recent statistics, this condition affects around 95% of our country's youngsters. The principal causative factor for the progression and onset of periodontal disease, as well as oral disorders such as dental caries, is biofilm on the teeth's surface.[1]

Preventing the buildup of biofilm and interrupting the development of biofilm on the tooth surface is the most efficient means of preventing illnesses of the oral cavity such as periodontal disease and dental caries. Mechanical techniques of cleaning, including as appropriate tooth brushing and flossing of the interdental regions, are the most popular ways for preventing the production of biofilm and biofilm-induced gingivitis. However, it is also recommended that chemical adjuvants be used in conjunction with mechanical cleaning procedures for a more effective and efficient manner of preventing biofilm on dental surfaces, caries, and gingivitis.[2]

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Several studies have been done in the past that support the use of chlorhexidine to inhibit the growth of bacteria in the biofilm on the teeth's surface. It is thought to be quite helpful

at reducing gingivitis and biofilm on tooth surfaces. However, in recent years, it has been shown that chlorhexidine has a number of drawbacks. Bitter taste, brownish discoloration of teeth, change in taste perception, resistance in oral cavity bacteria, ulceration of mucosa, and increased deposition of supragingival calculus are only a few of the negative effects.[3] As a result, it cannot be used as a mouthrinse for an extended period of time. Furthermore, it is not well received by patients, particularly children, who find it distressing. As a result of these findings, further research is needed to develop chlorhexidine alternatives that are as efficient against germs as chlorhexidine but are more easily tolerated by children. Alternatives from natural sources are being explored widely.[3]

Chlorhexidine replacements derived from natural sources are currently being researched. Water modified with magnets (magnetized water) has emerged as a viable option that has piqued academics' curiosity. It might be a more cost-effective and safer alternative to chlorhexidine. When water is held in close proximity to a magnet for an extended period of time, it develops magnetic qualities. Water treated with a magnetic field has a higher pH (9.2) and is more alkaline in nature. The surface tension of the water is reduced as a result of treatment in a magnetic field.[4] As a result, this water has a softer and sweeter flavor. The water becomes thinner, more wettable, and more easily absorbed. As a result, it has a greater ability to penetrate cell membranes and exert its effects. When a permanent magnet is kept in contact with water for an extended period of time, the water becomes magnetically charged and gains magnetic qualities such as energy building, activation, cleaning, and detoxification, according to researchers. There is a lot of oxygen in magnetized water. When some oxygen ions unite to form oxygen, that oxygen may dissolve in water almost instantly.[5] When we put magnetized water in a closed container, it forms little bubbles that adhere to the bottle's walls. Only a few studies have been undertaken to offer significant information on the usage of water treated with a magnetic field as an antibacterial agent in children's mouthrinses.[6] As a result, the emphasis of this study was on a 21-day comparison of water treated with magnetism against 0.2% chlorhexidine as a mouthwash for gingivitis and plaque inhibition in youth aged 12–15 years.

Materials and Methods

This was a clinical trial that was double-blinded and randomly controlled. The research was conducted at private high schools that were not affiliated with the government. The research was only begun when the institute's ethics committee gave its clearance. 2021/PAT/361 was the IEC approval number. The research was conducted in accordance with the Helsinki declaration's guidelines.[6] It was also ensured that official approvals from the appropriate authorities of the schools where the study would be conducted were obtained.

Sample Size

To obtain 80% power and 5% significance, a sample size of 24 people was necessary. As a result, the 24 youngsters were chosen using a simpler sample procedure. Each child, as well as their parents, signed a written informed consent form. Before receiving written informed permission, parents were given comprehensive information about the study.

Inclusion Criteria

The criteria for inclusion of study participants in this study were adjusted as follows:

- The age of the study participants was between 12 and 15 years
- Written consent was obtained from the children and their caretakers
- Index for gingiva assessment score ≥1
- Index for plaque assessment score ≥1
- No stains

Exclusion Criteria

The criteria for exclusion of the study participants were adjusted as follows:

- Children who had a history of systemic diseases
- History of use of mouthrinses
- History of scaling and root and planning within the last 6 months.
- Children having removable or fixed orthodontic appliances
- Children have removable appliances

Study Design

A pro forma was created and utilized to record all of the information about each research participant, including the values of the index for gingiva evaluation at baseline, the values of the index for plaque assessment at baseline, oral hygiene maintenance practices, and sociodemographic information. A computer-generated random number sequence was used to split the research participants into two groups at random. The first category included water that had been treated with a magnetic field (magnetized water). Mouthwash with 0.2% chlorhexidine was Category 2 (Septodont). Fresh magnetized water was prepared one day ahead and distributed at weekly intervals. As children are unable to consent, the use of a placebo is restricted in children. In both categories, there was one dropout after 14 days, and after 21 days one extra dropout occurred in each group. Finally, there were two dropouts in each category during the entire study (Flowchart 1).

Preparation of Magnetized Water and Coding of Samples

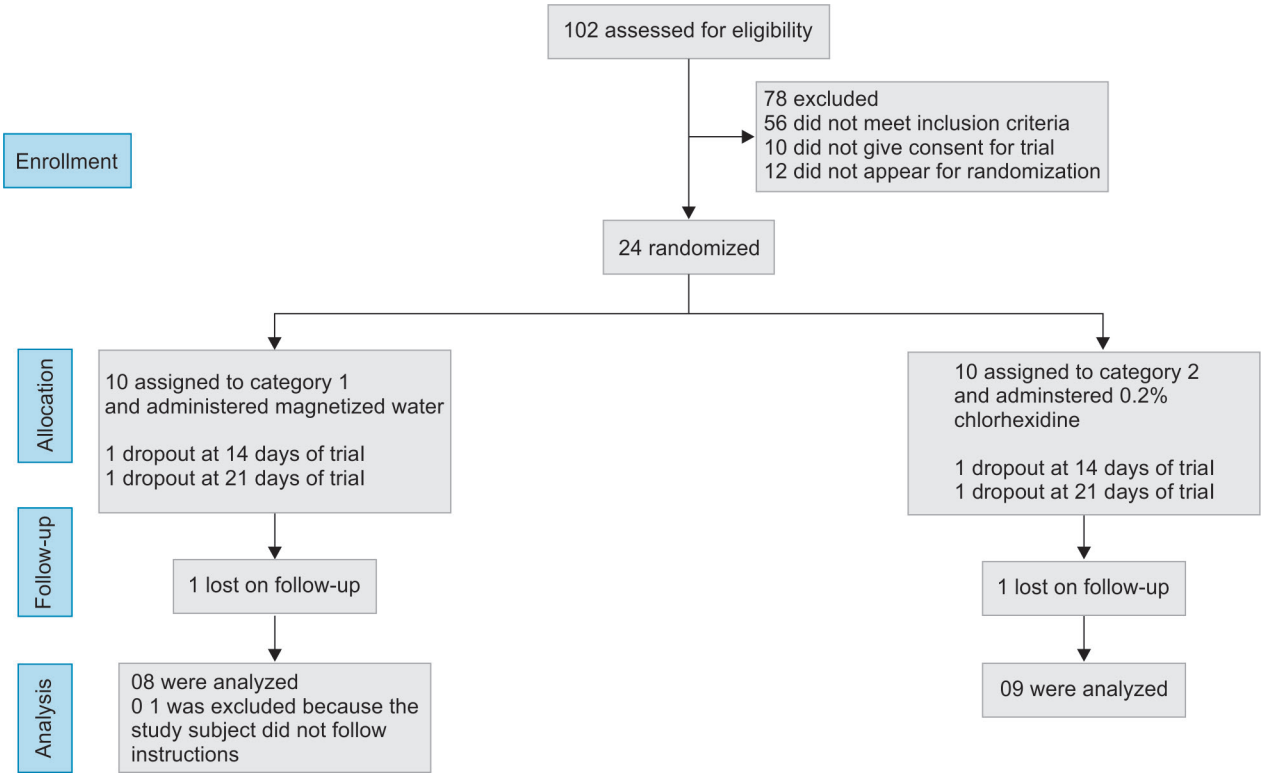
This is how the magnetized water preparation method was carried out. Water that had been purified using reverse osmosis was preserved in glass bottles and placed near the magnets. The magnets have 1000 Gauss power. The bottles were put for a period of 24 hours. The pH of the water was 7.8 before magnetization and 24.6 after magnetization. Chlorhexidine and water treated in a magnetic field were maintained in comparable bottles that were securely sealed. Before delivering it to the study participants, written instructions and correct labeling were placed on the bottles containing chlorhexidine and water treated with a magnetic field. The coding of the bottles was done by the same person, who had no knowledge of the study's design. This was done in order to create a double-blinded research design (Figs 1 and 2).

Methodology

The youngsters were given 140 mL of mouthrinse. They were told to use these mouthrinses at home. The nature of the mouthrinse supplied to the youngsters was kept a secret from both the research participant and the investigator. All of the youngsters who took part in the research were taught how to properly apply mouthrinse. The trial lasted 21 days, with a follow-up period of another 21 days.

The research participants were instructed to use 10 mL of the mouthrinse given in a cup with measurements on it. The duration of washing the oral cavity was 30 seconds, with two rinses every day, one in the morning and the other at night. The entire procedure was carried out for 21 days. Their parents or caregivers were present

Flowchart 1: Flowchart adhering to CONSORT



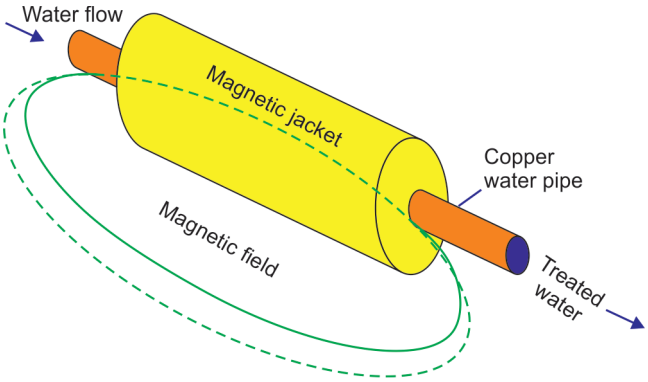


Fig. 1: Representative image of magnetization of water

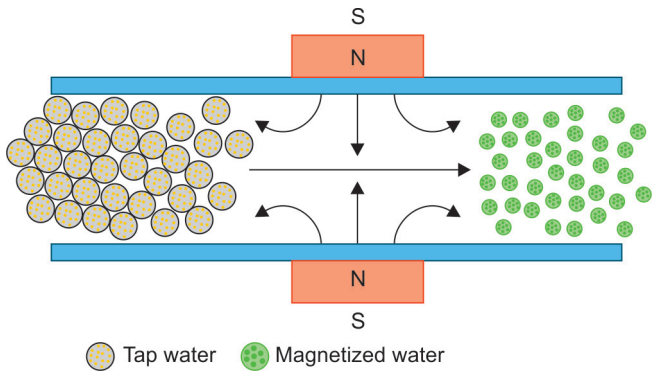


Fig. 2: Representative diagram of change in configuration of water molecules after magnetization

during the rinsing procedure. To monitor the implementation of the instructions given to the children, the parents were given a written 21-day itinerary. Children with regular eating habits, brushing habits, and other cofounding variables may skew the outcomes of the research. As a result, they were told not to eat anything for at least half an hour after using the mouthwash. All of the research participants were taught to use the same brushing technique and pattern. Both groups were instructed to rinse their mouths for 1 minute twice daily half an hour after brushing with the mouthwashes supplied to them for 21 days without dilution. Every research participant's food pattern was kept consistent, and parents were advised to stick to it. Throughout the trial, the participants were told to refrain from using any other mouthwash.

Clinical Assessment

Evaluation of plaque was carried out with the help of Gilmore Turesky modification of index for plaque advised by Quigley Hein while the index for gingivitis advised by Loe and Sillness was used for evaluation of gingiva. The analysis of index for plaque and index for gingivitis was performed at baseline, at 14 days, and at 21 days. The plaque disclosing agent, a two-tone dye (DPI, Alphaplac), was used before analysis of index for plaque and the index for gingivitis. The plaque disclosing agent was used with the help of cotton tips by the same person who was completely unaware of the design of the study. All clinical measurements were also carried out by the same examiner. Besides the timing of clinical examination was the same at all visits for assessment which was in the morning but not in a fasting state. Intraoral examination was carried out at every visit by the same examiner to analyze any adverse effects like erosions of oral mucosa and brownish stains of the teeth due to daily mouth rinsing. The children were also inquired about any other adverse

effects like bitter taste at each visit. They were asked to report as soon as any adverse effect was noticed in them.

Statistical Analysis

Before transferring data to the statistician there was the decoding of the information obtained in the study. The statistical tests used for statistical analysis were Student's paired *t*-test and Student's unpaired *t*-test. The value of significance was $p \leq 0.05$.

Results

In the second and third weeks of the trial, the participants were assessed. Table 1 contains information on the age and gender of the study participants in each group. The average age of study participants in Category 1 was 11.87 ± 0.58 years whereas the average age of research participants in Category 2 was 11.70 ± 0.88 years. In both groups, there was no statistically significant difference in the age of research participants. Male children made up 40% of the research participants in Category 1 and female children were 60%. In Category 2, in contrast, 50% of the youngsters who took part in the research were boys and the rest were females.

Table 1: Data showing the details regarding the age, sex and distribution of study participants

	Category 1	*Category 2*
Age in years ± SD (years)	11.87 ± 0.58	11.70 ± 0.88
Gender (%)		
Male	Six (60%)	Five (50%)
Female	Four (40%)	Five (50%)

At baseline, the second week duration, and the third week duration, each research participant's plaque and gingivitis indexes were recorded. At baseline, the mean of index for plaque values in Category 1 was 2.65 ± 0.59, whereas the mean of index for gingivitis values was 2.16 ± 0.06. The mean index for plaque levels reported at baseline in Category 2, however, was 2.41 ± 0.42 whereas the mean index for gingivitis was 2.18 ± 0.21. The statistical differences between the results observed in categories 1 and 2 were not significant (Table 2).

When the values of the plaque index were recorded after 14 days and 21 days, it was discovered that the reduction in the values of the plaque index was statistically significant in Category 1. At follow-up after 14 days and 21 days, similar reductions in the values of the plaque index were seen in Category 2 (Table 3).

At 14 days and 21 days, the values of the gingival index were recorded. It was discovered that the decrease in the values of the gingival index was statistically significant in both categories (Table 4).

When the reduction in the values of the index for plaque and index for gingivitis after 14 days and 21 days was compared between the categories, the difference was not statistically significant (Table 5).

When comparing the occurrence of bitter metallic taste and brown stains, adverse effects were detected more frequently in Category 2 than in Category 1's unfavorable effects.

Finally, both water treated under magnetic field and chlorhexidine was shown to be similarly efficient in reducing periodontal and gingival diseases whereas undesirable effects

Table 2: Data showing the change in the values of index for plaque assessment and index for gingiva assessment at baseline

	Category 1		*Category 2*		
	Mean value	*SD value*	*Mean value*	*SD value*	*t value, p value*
Index for plaque assessment at baseline	2.65	0.59	2.41	0.42	2.31; 0.33
Index for gingiva assessment at baseline	2.16	0.06	2.18	0.21	1.31; 1.88

Table 3: Data showing the change in index for plaque assessment at 14 days follow-up and 21 days follow-up

Categories	*Duration*	*Mean values*	*N values*	*SD values*	*Mean difference values*	*t value, p value*
Category 1 (water treated with high magnetic field)	At baseline duration	2.65	12	0.59		
	14 days	2.29	12	0.49	0.47 ± 0.28	8.72: 0.02
	21 days	0.99	12	0.29	0.77 ± 0.42	7.70: 0.02
Category 2 (chlorhexidine of concentration 0.2%)	At baseline duration	2.42	12	0.42		
	14 days	2.14	12	0.31	0.39 ± 0.23	8.41: 0.02
	21 days	1.89	12	0.21	0.64 ± 0.33	8.69: 0.02

Table 4: Data showing the change in index for gingiva assessment at 14 days follow-up and 21 days follow-up

Categories	*Duration*	*Mean value*	*N values*	*SD values*	*SEM values*	*Mean difference values*	*t value; p value*
Category 1 (water treated with high magnetic field)	At baseline duration	2.16	12	0.06	0.02		
	14 days	0.91	12	0.09	0.03	0.36 ± 0.11	9.99, 0.02
	21 days	0.76	12	0.25	0.05	0.51 ± 0.24	9.67, 0.02
Category 2 (chlorhexidine of concentration 0.2%)	At baseline duration	2.18	12	0.21	0.04		
	14 days	0.96	12	0.19	0.03	0.32 ± 0.17	22.33, 0.02
	21 days	0.50	12	0.19	0.03	0.68 ± 0.23	25.79, 0.01

Table 5: Data showing comparison between the Category 1 and Category 2

	Category 1		*Category 2*		
Duration	*Mean value*	*SD value*	*Mean value*	*SD value*	*t value; p value*
Decrease in index for plaque assessment					
At 14 days	0.47	0.28	0.39	0.23	1.26; 0.37
At 21 days	0.77	0.42	0.64	0.33	1.15; 0.42
Decrease in index for gingiva assessment					
At 14 days	0.36	0.10	0.32	0.17	1.43; 0.31
At 21 days	0.51	0.24	0.68	0.23	3.01; 0.04

such as bitter metallic taste and brown stains were less prevalent in water treated under magnetic field.

Discussion

There have been reports of negative consequences from using chlorhexidine as a mouthrinse. These side effects are mostly localized, such as brownish discoloration of teeth, alterations in taste perception, and erosion of the oral mucosa. Because chlorhexidine has such negative side effects, it was necessary to do research, particularly in children, to identify a replacement that is similarly efficient against germs but does not have these side effects.[6] Because chlorhexidine is regarded the gold standard in the field of mouthrinse against gingivitis and periodontal plaque buildup, water treated under a magnetic field was compared to chlorhexidine to determine its efficiency in treating periodontal illnesses and gingival disorders.

Wevangti Vangra claims that when water is treated with a magnetic field, the ionic charge of water increases electrically in contrast to minerals. As a consequence, a magnetic attraction forms spontaneously between the water treated with a magnetic field and the minerals. There is also a reduction in the size of water molecules. It resulted in the water treated in a magnetic field tasting better and softening. Furthermore, the water molecule's solubility is improved as a result of its smaller size.[7]

Because it hinders the process of bonding, which happens when bacteria colonize and bind to the surfaces of teeth, water treated with a magnetic field is helpful against gingivitis and plaque development. The water treated in a magnetic field works on the magnetohydrodynamics principle, which claims that a magnetic field prevents mineral deposits in fluid from solidifying. This approach is used in the oral cavity to avoid plaque formation by preventing the buildup of extracellular polysaccharides contained in saliva as solid deposits on the teeth's surface.[8]

The antibacterial activity of the mouthrinse was evaluated over a three-week period in our investigation. This time frame was chosen since a previous study found that a three-week period is beneficial in lowering microbe colonies by mouth rinsing. Furthermore, Bhattacharjee et al. found that using mouthwashes for more than a year is neither practicable, realistic, or cost efficient because gingivitis and plaque may be reduced significantly in just two to three weeks with good care. Chlorhexidine is a cationic bis biguanide.[9] Its antibacterial action is quite wide, and its toxicity is extremely low. Its mechanism of action includes blockage of acidic functional groups present in glycoproteins of saliva. It prevents the ability of the polysaccharides present extracellularly to attach with the surfaces of a tooth.[10]

The results of the current study showed that both chlorhexidine and water treated with a magnetic field had similar activity because they were equally effective in reducing periodontal and gingival diseases, but that adverse effects such as a bitter metallic taste and brown stains were more common in study participants who used chlorhexidine. In addition, youngsters found that water treated with a magnetic field had a nicer flavor and was softer than chlorhexidine.

Nagpal et al. conducted a similar study in which they compared the effectiveness of chlorhexidine and water treated with a magnetic field in reducing periodontal and gingival diseases and discovered that while both agents were effective, chlorhexidine had more adverse effects such as bitter taste and brown stains. The findings are comparable to what we found in our research.[11]

Lone et al. compared the effectiveness of chlorhexidine and water treated with a magnetic field in decreasing periodontal and gingival disorders. The findings of this investigation matched the findings of the current study.[12] In comparison to a placebo effect, Shyam and Freed conducted tests to investigate the function of chlorhexidine in the management of periodontal and gingival illnesses and discovered that chlorhexidine in 0.2% concentration was highly efficient in the reduction of periodontal and gingival diseases.[13] There was also a substantial reduction in the values of the index for plaque and index for gingivitis in children who received chlorhexidine at fourteen and twenty-one days compared to the baseline values in our research.

Gupta compared the effects of chlorhexidine and water treated with a magnetic field on *Streptococcus mutans* contained in biofilm at the tooth surface. Chlorhexidine was shown to be more efficient than water treated with a magnetic field in lowering the number of colonies of *Streptococcus mutans*.[14] The findings of this study contradict the findings of our investigation, which demonstrated no significant difference in the efficacy of both medicines in decreasing the effects of periodontal and gingival illnesses.

Lang et al. conducted a research in which one hundred fifty-eight children aged ten to twelve years old were given chlorhexidine to use in mouth cleaning under supervision. The use of chlorhexidine at concentrations of 0.1 percent and 0.2 percent was shown to be highly effective in decreasing periodontal and gingival disorders in youngsters.[15] The findings of this study are consistent with current research, which shows that chlorhexidine is useful in minimizing the effects of periodontal and gingival disorders. Santos performed another investigation, which found that mouthwashes containing chlorhexidine were quite successful in lowering bacterial counts.[16]

Goyal and colleagues tested the antibacterial efficacy of water treated with a magnetic field against bacteria found in plaque and saliva. Water treated with a magnetic field was shown to be a viable alternative to traditional chlorhexidine mouthwashes.[17] The findings are comparable to what we found in our research.

Chlorhexidine was employed at a concentration of 0.2% in this investigation because, according to Menendez et al., chlorhexidine, when administered at low concentrations like 0.12%, is ineffective in lowering the amount of antimicrobial colonies found in plaque.[18] It is, nevertheless, highly effective when administered at lower concentrations, such as 0.2%. Moran and Addy conducted a research and found that 10 mL of chlorhexidine mouthrinse at a concentration of 0.2% was an appropriate dosage.[19]

Children in our research were instructed to use 10 mL of each mouthwash for 30 seconds twice a day (once in the evening after dinner and other in the morning before the breakfast). This was done based on the idea that increasing the volume and frequency of mouthrinse increases the concentration of the antibacterial ingredient in mouthrinses.

In this study, it was shown that water treated with a magnetic field was highly successful in reducing periodontal and gingival issues after 14 and 21 days, with no detrimental effects like as brown stains or bitter taste. Furthermore, compared to chlorhexidine, which was judged to be softer and sweeter by the youngsters, its flavor was easily accepted by them.

This study's therapeutic implications were that water treated with a magnetic field might be used instead of chlorhexidine mouthwash, especially in youngsters. Our study has the limitation that even though effectiveness and harmful effects were evaluated after 14 and 21 days, there was no examination of efficacy and detrimental effects for at least 6 months. Besides that, the sample size was too small. As a result, further research with a bigger sample size and long-term follow-up should be conducted in the future.

Conclusion

Because of its well-accepted flavor, softer nature, and lower incidence of brown stains, water treated under a magnetic field can be a safer and more acceptable alternative to chlorhexidine mouthwashes, especially in youngsters.

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