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Desensitizing Effect of Sodium Bicarbonate Mouthwash in Patients with Dentinal Hypersensitivity–A Clinical Trial

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Introduction

Dentin Hypersensitivity (DH) is a major complaint of the general population. Reports have indicated the incidence of DH is found in 4 to 74 percent of the population.[1] It poses a challenge for clinicians because its' presentation is ambiguous with no specific signs.[2] Dentists rely on the patient's clinical and dietary history and a thorough intraoral examination using thermal and tactile stimuli. Dentin receptors have a unique feature of eliciting pain as a response to any environmental stimulus. The sensory response in the pulp cannot differentiate between heat, touch, pressure or chemicals, because they lack specificity. Irrespective of the type of stimulus, the patient perceives any stimulus as a pain.[3] Hence careful examination should be performed to rule out other conditions which present in a similar manner to DH. These include cervical caries, leakage around decayed or fractured restorations, cracked teeth and palatogingival grooves.[4] Continual research takes place to check the efficacy of desensitizing agents to treat DH as no treatment modality is widely accepted as the gold standard.

Various terminologies have been used for this condition including dentin sensitivity, tooth sensitivity, cervical dentin sensitivity, cemental sensitivity or hypersensitivity and tooth hypersensitivity. The term hypersensitivity represents a pathological situation in which treatment of DH is essential.[5] The incidence of DH in most of the population groups ranges from 10 to 30 percent of the general population with an age range of 20 to 50 years. The peak prevalence is reported at the end of the third decade of life and decreases during the fourth and fifth decades. This may be explained by the decrease in the permeability of dentin and neural sensitivity, natural desensitization due to sclerosis and secondary dentin formation with increasing age. Even the prolonged use of fluoridated dentifrices may cause occlusion of dentinal tubules resulting in decreased sensitivity.[4] The higher incidence of DH as seen in females than males can be attributed to hormonal influences and dietary habits, although the results are statistically insignificant. DH may involve a single tooth, group of teeth, area of the mouth or it can be generalized. The most commonly affected teeth are premolars and canine of both arches, followed by maxillary first molars and incisors reported being the least sensitive. Cervical regions on the facial aspect are the most commonly involved areas.[4]

Various theories and mechanisms responsible for DH have been proposed for over a century. Gysiin in 1900 attempted to explain the hypersensitivity of teeth and described fluid movement in the dentinal tubules.[6] The hydrodynamic theory was proposed by Brännström in 1963.[7] This is the most widely accepted theory which is based on fluid movement inside the dentinal tubules as a response to various stimuli. Any change in temperature or physical or chemical changes create a disturbance in the fluid which is present inside the dentinal tubules. This movement of the fluid acts as a stimulus for baroreceptors causing neural discharge which is ultimately perceived as a DH or pain by the patient. Stimuli like cold, drying, hypertonic chemicals and evaporation cause outward movement of the dentinal fluid (i.e. away from the dentin-pulp com-

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plex) whereas heat or mechanical stimulation causes fluid to flow towards the pulp.[8]

The prevalence of DH in periodontitis patients is considerably high and it is observed between 72.5 to 98 percent of the patients. DH may be present prior to treatment or may occur after surgical and non-surgical periodontal therapy. In a systematic review by Lin in 2011, the prevalence of DH after non-surgical periodontal therapy was reportedly between 62.5 to 90 percent while DH after surgical intervention was observed to be 76.8 to 80.4 percent of the treated patients.[9] Periodontal treatment includes the removal of hard and soft deposits present on the surface of teeth. Periodontal instrumentation can remove 20 to 50μm of cementum leading to opening of the dentinal tubules.[10] Inflammation of the marginal gingiva will be reduced after periodontal therapy with the resultant shrinkage of the tissues seen as gingival recession. These factors along with plaque accumulation contribute to the development of DH. When patients experience DH, they tend to avoid brushing in the sensitive areas due to discomfort. The resulting plaque accumulation in the area can cause further root sensitivity. In a recent study, Barbosa et al demonstrated that chronic mild stress aggravates the nociceptive response associated with DH in a rat model.[11] Numerous treatment modalities have been proposed to alleviate DH. Primarily they can be divided into two types such as agents occluding open dentinal tubules and nerve desensitizing agents. Various agents including calcium hydroxide, oxalates, fluorides, strontium chloride, cements, varnishes, resins etc. are used as desensitizing agents.

Sodium bicarbonate or baking soda is one such agent which has a historical value in oral hygiene regimens and was regarded as "the ideal tooth powder".[12] Several beneficial properties of sodium bicarbonate make it a potential desensitizing agent. Its chemical properties, high safety profile, low abrasively, buffering capacity, compatibility with the fluorides, availability, and low cost makes it an appealing agent to treat DH. Recently, Rikame et al.in 2018 reported in a scanning electron microscopic study obliteration of open dentinal tubules after treatment with sodium bicarbonate making it a scientifically based option to treat DH.[13] Potassium nitrate has been considered the most effective agent in treating DH. Hodosh (1974) was the first to report it as a "superior desensitizer".[14] The exact mechanism by which potassium nitrate reduces DH is still not confirmed. Nerve desensitization has been proposed to be the main mechanism of action due to active potassium ions. Potassium ions reduce dentinal sensory nerve activity by the depolarizing activity. Also, an oxidizing effect or occlusion of dentinal tubules by crystallization has been proposed but not proven.[1] This study was designed to evaluate the effect of 2 treatment modalities and a control on dentinal hypersensitivity before and after surgical periodontal therapy.

Materials and methods

Ninety patients were included in this study on treatment for root sensitivity based on recommendations by the biostatistician, the study design and study groups. Subjects were selected from the Out Patient Department (OPD) of Pandit Deendayal Upadhyay Dental College, Solapur, India who had come to seek dental treatment. The study protocol was presented to the institutional Review Board and Ethical Committee for ethical clearance. The proposed study design was reviewed and approved. The information about the study was explained to the patients in the understandable language and verbal and written informed consent was obtained from them. Of the ninety patients included in the study, forty one patients were female and forty nine were male. They ranged from 25-65 years with an average of 41.84 years. This study was conducted in the Department of Periodontics from June 2017 to August 2018.

Every patient requiring periodontal surgical therapy was checked for the presence of DH and a Visual Analogue Scale (VAS) score was recorded preoperatively. From these treated patients ninety subjects with persistent or aggravated DH were included in the study. Subjects were randomly divided into three groups of thirty. One group of 30 subjects was asked to rinse by using ½ teaspoon sodium bicarbonate i.e. baking soda aqueous solution twice a day after regular brushing of teeth. Baking soda was dispensed in sachets by the department. Another group of 30 subjects was asked to use 3% Potassium Nitrate mouthwash-Senquel AD (Dr. Reddy's Laboratories, Hyderabad, and Telangana, India). Control group subjects were asked to use distilled water as mouthwash which was a placebo.

Subjects were examined for hypersensitivity by stimulating buccal surfaces of exposed roots with 3 stimuli (1) Mechanical stimulation with a No. 23 dental explorer (tactile test); (2) Cold water; (3) A compressed air blast from an air syringe. Responses were evaluated utilizing the Visual Analogue Scale (VAS)[15] 1 week before surgery (T_0) and 1, 2, 4 weeks and, 3 months (T_1, T_2, T_3 and T_4) following surgery. Gingival index-Loe H and Silness J1963(GI),[16] and plaque index–Silness P and Loe H 1964 (PI)[17] were also checked at baseline and during subsequent visits. Modified sulcular bleeding index Mombelli A et al.1987 (mBI)[18] was recorded as baseline before surgery and 3 months after surgery as it is not advisable to be probe the treated area before that.

These parameters were recorded at following intervals. T_0–Baseline, before one week of surgery, T_1–One week after surgery, T_2–Two weeks after surgery, T_3–Four weeks after surgery, T_4–Three months after surgery.

Results

The present study was performed to check and compare the desensitizing efficacy of two test mouthwashes and a control mouthwash. The results of this study have shown positive results for both of the test groups. Sodium bicarbonate (baking soda) aqueous solution has reported to be highly effective in reducing DH.

Visual analogue scale (VAS)

Mean VAS score was comparable in all the three study groups at the start of the study. Patients who developed DH after surgical periodontal therapy were included in the study. DH score was recorded using tactile test (mechanical stimulation using No. 23 ex-

plorer), compressed air blast using three way syringe and thermal test using cold water. Each subject was assessed for DH using these three parameters and the pain response was recorded on Visual Analogue Scale (VAS). Each parameter was scored out of ten and total score was obtained by adding all the values, out of thirty. The DH score was the lowest in the baking soda group 3 months post-surgery. The potassium nitrate group demonstrated a significant decrease in the VAS score as compared to control group.

The rate of reduction of DH was faster in the baking soda group than both of the other groups. Mean reduction in DH after 1week of prescribing baking soda mouthwash was 6.73 whereas mean reduction in DH for potassium nitrate group and control group was 3.17 and 2.43 at one week respectively. At the three month follow up, subjects having a VAS score≤2 out of 30 were regarded to be free from DH. They were reported to experience mild discomfort but no pain. Many subjects from all the three groups presented with complete relief from DH after three months. The percentage of subjects with complete relief was significantly more in the baking soda group followed by the potassium nitrate group and then the control group. In test group I who used baking soda mouthwash, 70% of patients reported complete relief. Comparatively, the frequency in group II with 3% potassium nitrate was 56.67% and the control group who used distilled water the reduction was only 26.67%.

Statistically significant differences were seen at various time intervals between all the three groups. After applying the ANOVA test, the obtained p-value for time intervals T_2, T_3 and T_4 (i.e. after the start of the DH treatment) is 0.000, 0.012 and 0.005 respectively. The mean VAS score was the least in baking soda group followed by potassium nitrate and control group. Rate of reduction of DH was the highest in baking soda group followed by potassium nitrate and control group.The subjects who used baking soda mouthwash were very satisfied with the results. They experienced immediate relief and actively participated in the study after having been prescribed the mouthwash. The subjects reported no discomfort after surgical therapy, "tightness in the gums" and decreased tooth mobility. Patients came to the department asking for the "white powder" on their own as they experienced complete relief. Many subjects recommended other patients to use baking soda for DH.

Gingival index

The mean gingival index score for all the three groups was between 0.1 and 1.0, which is indicative of mild gingivitis. Baseline scores were recorded one week prior to surgery. As the patients were treated with prior oral prophylaxis, gingival health was good. All three groups recorded linear regression in gingival index score. Statistically significant difference in the gingival index score was recorded during T_2 (one week after prescribing mouthwash) and T3 (one month after surgery) i.e. p-value 0.001 and 0.029 respectively. Mean gingival index score was minimum for baking soda group followed by potassium nitrate and control group. This trend is followed throughout the study, although the difference in the mean gingival index score was not statistically significant (p-value: 0.861) at the end of three months.

Plaque index

All the subjects were assessed for accumulation of plaque and plaque index was recorded during subsequent visits. Plaque index score was less at the baseline reading as the subjects underwent non-surgical therapy before periodontal flap surgery. Mean plaque score was drastically increased after one week of surgery because of inability to maintain good oral hygiene due to treated surgical sites and DH. A linear relationship was seen between the DH VAS score and plaque index score. As the DH decreased, a reduction in the plaque score was reported. Plaque accumulation was the minimum in the baking soda group and it was maintained at low level throughout the study. Moderate plaque score was recorded in potassium nitrate group. Control group plaque score was more throughout the study and no significant reduction was reported as compared to other test groups. Although mean plaque index score was reduced during subsequent visits in control group as well.

Difference in the mean plaque index score for all the three groups was highly statistically significant for the time intervals T_2, T_3 and T_4 i.e. p-value: 0.000. The least mean plaque score was obtained for baking soda group, moderate for potassium nitrate group and was the maximum for control group with placebo mouthwash.

Modified sulcular bleeding index

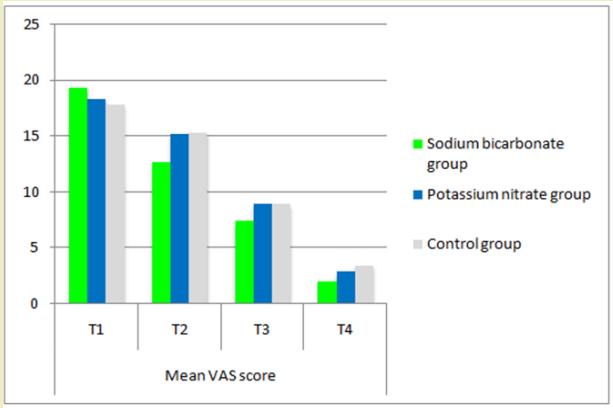

Figure 1: Graph showing reduction in DH scores after prescribing respective mouthwashes at various intervals.

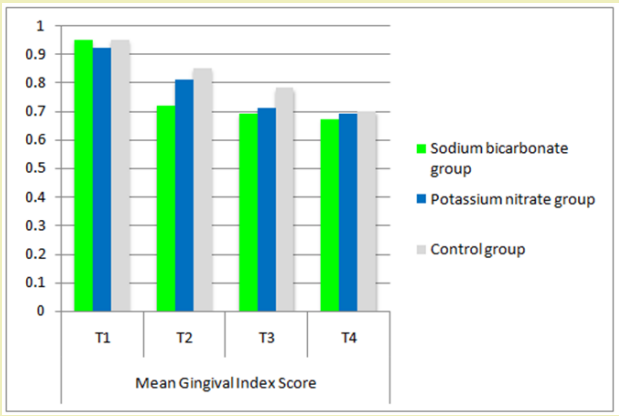

Figure 2: Mean Gingival Index score at various time intervals.

Modified sulcular bleeding index was recorded at the baseline one week before surgery and 3months after surgery. The surgically treated area was not probed in between during subsequent visits when other parameters were assessed so as not to disturb the process of healing. All the groups have shown decrease in the sulcular bleeding. The mean reduction in bleeding score was the maximum in baking soda group followed by potassium nitrate and control group i.e. 0.45, 0.29 and 0.21 respectively. The difference in the mean modified sulcular bleeding was statistically significant with the p-value 0.000.(Figure 1-Figure 5)

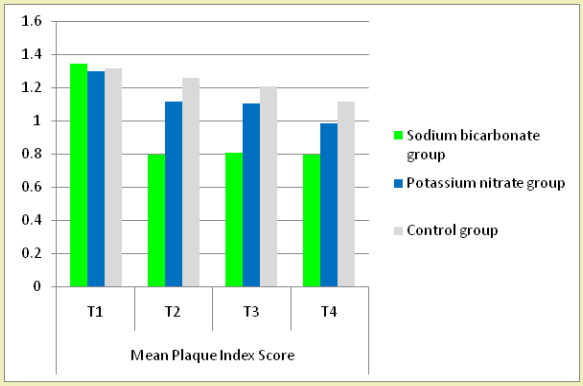

Figure 3: Mean Plaque index score at various time intervals.

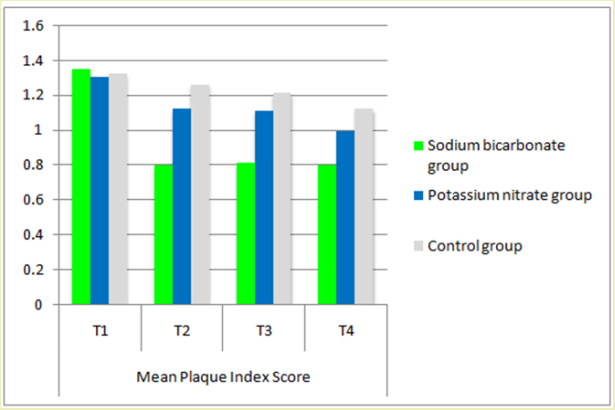

Figure 4: Mean Modified Sulcular Bleeding Index score at baseline and after three months.

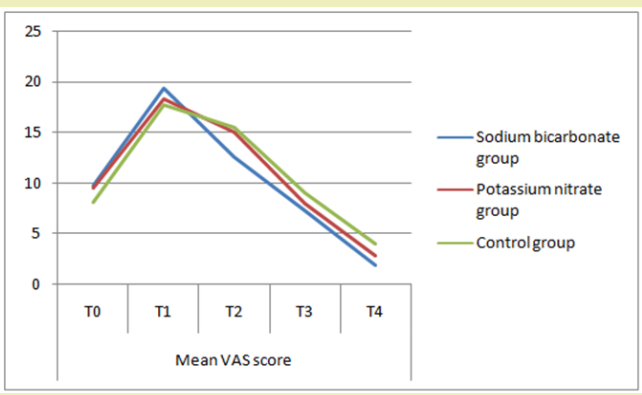

Figure 5: Changes in the Mean DH score from baseline (before periodontal surgical therapy) to three months after surgery.

Discussion

Many patients who visit the periodontist suffer from DH or develop DH after surgical or non-surgical periodontal therapy. Many studies have shown that DH is transient and diminishes with time. Providing immediate relief will aid the patient's ability to maintain good oral hygiene as shown in this study. It has been reported that 76.8 to 80.4 percent of the patients treated with surgical periodontal therapy develop DH.[9] There are various possible reasons. Before periodontal therapy the affected area is layered with deposits. The first phase of treatment to achieve healthy periodontium is an initial oral prophylactic phase. This results in the removal of deposits for good reasons but exposes underlying affected area leading to DH. Periodontal instrumentation inevitably removes some amount of cementum exposing open dentinal tubules. Gingival tissue shrinks while undergoing healing after the treatment. This shrinkage causes recession of the gingival margin, which is one of the commonest causes of the DH.[19-21]

Potassium nitrate is termed as the gold standard over-the-counter agent used in the treatment of DH.[22] Although a recent review has reported potassium nitrate is not a predictable treatment option for DH due to inferior results.[23] The exact mechanism by which potassium nitrate reduces DH is still not confirmed. Nerve desensitization has been proposed to be the main mechanism of action due to the depolarizing action of potassium ions. Moreover it has been hypothesized that potassium nitrate occludes dentinal tubules by an oxidizing effect or crystallization, but strong evidence is not available.[14] Baking soda or sodium bicarbonate is a crystalline salt. The scanning electron microscopic images of teeth specimens treated with sodium bicarbonate have shown uniform amorphous crystalline deposition on the open dentinal tubules.[13] Complete obliteration of dentinal tubules has been reported. As the crystal size is bigger than the tubule diameter baking soda crystals have not occluded the dentinal tubules by entering inside the tubule opening. Repeated application of baking soda is advisable to have sustained relief from DH. No chemical reaction with the tooth structure or discomfort is reported by the patients after the application of baking soda mouthwash. Sodium bicarbonate mouthwash acts by forming a crystalline deposition on the surface of a dentin and the open dentinal tubules get obliterated alleviating the DH.

The analysis of mean visual analogue scale scores of all the three groups has displayed a decrease in the post treatment DH along the course of time. Mean reduction in the VAS score after one week of prescribing mouthwashes was significantly larger in baking soda group than other two groups (p-value–0.000). Reduction in the mean VAS score for baking soda group was 6.73 whereas that for potassium nitrate group and control group was 3.17 and 2.43 at one week respectively. The DH VAS score reduction was comparable at one month interval following surgery. For the baking soda group, potassium nitrate group and control groups it was 5.24, 6.23 and 6.40 respectively. Though the reduction in the hypersensitivity score for the baking soda group was less, the mean VAS score was the least in the baking soda group. This indicates that baking soda

is highly effective in reducing DH within a short period of application. The standard deviation was the highest in the control group (3.38) and comparable in baking soda group (1.26) and potassium nitrate group (1.36). This indicates that the desensitizing effect of baking soda (sodium bicarbonate) mouthwash and potassium nitrate mouthwash were more predictable. Moreover, 26.67% of subjects from the control group reported complete relief from DH. This supports the findings from previous studies that post-operative DH is transient in many patients. Numerous studies have even reported the effectiveness of a placebo mouthwash in reducing DH. This very large placebo effect certainly goes a long way to explain several DH studies finding either little or no difference between the control and the test products.[24,25] This does not necessarily rule out a therapeutic effect for the test product but clearly demonstrates that when individuals take part in a clinical trial on DH, for some indistinct reasons, they show an improvement in symptoms.[26]

Numerous studies describe the efficacy of sodium bicarbonate as an essential agent of the dentifrices but limited literature is available on the effect of sodium bicarbonate mouthwash and its use a desensitizing agent. Because of its numerous advantages such as biocompatibility, buffering capacity, low abrasively, whitening properties, low cost and compatibility with the fluorides, baking soda was regarded as an ideal tooth powder to clean the teeth.[12] It does not add to DH as it is low in abrasiveness. Earlier baking soda dentifrices were marketed as anti-gingivitis agents, retarding calculus formation and even as desensitizing dentifrices.[27] A randomized clinical trial was conducted to check the desensitizing effect of the dentifrice containing EMS salts. EMS salt is an alkaline solution (pH 8.0-9.0) containing largely bicarbonate ions rather than the chloride ions present in isotonic saline (pH 6.4). This study has shown that the toothpaste containing bicarbonate ions was superior in reducing DH to control toothpaste. Some dentifrices containing triclosan and herbal ingredients were reported to be superior to baking soda dentifrices in few clinical trials.[28]

Subjects who used baking soda reported to have a psychological benefit. They experienced an improvement in the tone and consistency of gingiva and subjective tooth mobility was decreased. Strong alkalinity of the sodium bicarbonate salt could be the possible reason behind this effect. As reported in various skin care treatments baking soda is considered to be effective in skin tightening and improving the skin tone.[29] Subjects were asked to prepare the baking soda mouthwash by dissolving a half teaspoon of baking soda in a half glass of water and to rinse twice a day after brushing the teeth. Potassium nitrate mouthwash was prescribed as an over-the-counter drug. Active participation of subjects could have had an additive effect on the psychological benefit and positive outcome of the study for baking soda.

Mean plaque index score was significantly increased at the time of reading one week after periodontal surgery in all three groups when patients tend to avoid brushing in the treated area. Presence of sutures and fear of disturbing the wound leads to the accumulation of plaque in the area which can increase DH. After periodontal surgery patients might undergo some amount of stress as a physiological process. According to recent concepts stress has shown to increase DH in a rat model.[11] These factors have synergistic effect leading to DH in surgically treated patients which was clearly observed in the present study. Mean plaque index score was minimum in the baking soda group followed by potassium nitrate and control group. The difference was statistically significant with a p-value of 0.000. Studies have reported a significant decrease in plaque accumulation and gingival inflammation after using dentifrice containing baking soda. The anti-plaque property of baking soda is widely reported in the literature and many studies have demonstrated a decrease in the plaque score after using sodium bicarbonate dentifrices.[27] It has deleterious effects on periodontal pathogens including Actinomyces species and its virucidal property has also been documented.[21]

Baking soda is also called as saleratus which means aerated salt. When it is dissolved in the water, air is circulated. To preserve this property of 'aeration', baking soda powder was dispensed to the subjects in the sachets by the department instead of an aqueous solution. The participants were asked to freshly prepare the mouthwash just before the rinsing. Aeration of sodium bicarbonate in the aqueous solution leads to the formation of micro-bubbles. That might cause disruption of the supragingival plaque biofilm and decrease in the plaque accumulation. A review has reported that baking soda is superior in removing the plaque from difficult to reach or less accessible areas of the dentition.[30] Sodium bicarbonate mouthwash is reported to be an effective intervention to improve oral health in cancer patients undergoing chemotherapy. Although the oral bacterial colonization was more in sodium bicarbonate group than chlorhexidine group, occurrence of oral ulcerative mucositis was significantly lower in the sodium bicarbonate group.[31] It is recommended to use baking soda mouthwash in patients suffering from xerostomia or erosion. Due to its ability to increase salivary pH it suppresses the growth of aciduric micro-organisms.[32] Sodium bicarbonate improves taste and neutralizes acids and thus prevents erosion of tooth surface. The bland nature of sodium bicarbonate makes it tissue friendly even in patients with xerostomia and oral ulcers.[33]

Mean gingival index score was the maximum for control group followed by potassium nitrate group and was the least for baking soda group. The difference in the mean gingival index score at the end of three months after surgery was not statistically significant (p-value–0.861) but numerically it was the minimum for baking soda group. Studies have shown positive effects on gingival and periodontal health when baking soda dentifrice was used.[34-36] It has been proven to have anti-inflammatory and anti-gingivitis properties. Many studies have demonstrated a reduction in the gingival inflammation after using baking soda dentifrices.[37] In one of the clinical trials, chronic periodontitis patients were asked to use the sodium bicarbonate slurry as an adjunct to the non-surgical periodontal therapy. Oxidative stress was measured by recording the level of salivary malondiadehyde. Improvement in the clinical parameters and reduction in the oxidative stress was reported after the use of sodium bicarbonate slurry.[38]

Bleeding on probing (BOP) is one of the earliest signs of active gingival inflammation. In all groups, BOP was reduced as all other parameters were decreased by the end of the study. Bleeding index score was recorded at baseline before surgery and three months following surgery to not disturb the process of healing after surgical therapy. One of the recent studies has checked the efficacy of baking soda dentifrice on gingival bleeding. The researchers observed significant reduction in the number of bleeding sites and no incidence of adverse effects was reported emphasizing the high safety profile of baking soda for intraoral use.[36] A randomized clinical trial was conducted to evaluate the immediate relief in DH after applying various concentrations of potassium nitrate gel. This in vitro study suggested the usefulness of 10% potassium nitrate gel in alleviating DH during four days of application.[39] In the present study, with all the explanations discussed above sodium bicarbonate aqueous solution seems to be more effective in reducing post-surgical DH. Potassium nitrate mouthwash is effective in reducing DH but its efficacy is reported to be lower than sodium bicarbonate mouthwash. Potassium nitrate has failed to decrease the DH in many studies when compared with other agents such as strontium chloride, sodium fluoride, calcium sodium phosphosilicate and formalin.[40]

Conclusion

Sodium bicarbonate and 3% potassium nitrate, both the study groups reported substantial decrease in the DH. Baking soda provides immediate relief within one week of application. reduction in the DH was significantly more in the sodium bicarbonate group than in the potassium nitrate and control groups. Mean plaque score, gingival index score and mean modified sulcular bleeding index score were the least in sodium bicarbonate group followed by the potassium nitrate and control groups.

After analysing the results of this in vivo study we can conclude that:

A. Baking soda is effective in decreasing DH after periodontal flap surgery. The percentage of completely relieved subjects at the end of three months in baking soda group was 70%.

B. Three percent potassium nitrate mouthwash is an effective desensitizing agent in reducing post-treatment DH. The percentage of completely relieved subjects at the end of the study in 3% potassium nitrate group was 56.67%.

C. Within the limitations of this study baking soda mouthwash is reported to be a superior desensitizer than 3% potassium nitrate mouthwash in reducing post treatment DH.

Further clinical trials with various concentrations of baking soda are needed to improve the predictability of results.

The present clinical trial has shown that sodium bicarbonate aqueous solution or baking soda mouthwash is highly effective is reducing DH after surgical periodontal therapy. Baking soda is biocompatible, readily available, economic and novel option in treating DH. Additionally, baking soda has reported to provide psychological benefit to the patients like improvement in the consistency and tone of the gingiva and decrease in the mobility of teeth. By decreasing DH, patients demonstrate better plaque control and improvement in gingival conditions post-surgery. This may lead to better long-term results.

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Conflicts of interest

Author declares that there is no conflict of interest.

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