Effects of 0.05% sodium hypochlorite oral rinse on supragingival biofilm and gingival inflammation

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Objective: This study aimed to evaluate the clinical effects of 0.05% sodium hypochlorite mouth rinse on supragingival biofilm and gingival inflammation. Methods: The study was performed as a controlled, randomised, investigator-blinded, parallel group trial in 40 prison inmates. Following a preparatory period to obtain a plaque- and gingivitis-free dentition, tooth-brushing was substituted for 21 days by supervised twice daily rinsing with either 15 ml of fresh solution 0.05% sodium hypochlorite or 15 ml of distilled water. Clinical outcomes were assessed using the Quigley–Hein Plaque Index (QHPI), the Löe and Silness Gingival Index (L&SGI) and bleeding on probing. Adverse events were evaluated by questionnaire, visual examination and clinical photographs. Results: At day 21, the average QHPI score had increased to 3.82 in the water rinse group and 1.98 in the sodium hypochlorite rinse group. The average L&SGI score had increased to 2.1 in the water rinse group and 1.0 in the sodium hypochlorite rinse group, and the average percentage of sites that bled on probing had increased to 93.1% in the water rinse group and 56.7% in the sodium hypochlorite rinse group. Differences were statistically significant (P = 0.001). A brown extrinsic tooth stain along the gingival margin appeared in 100% of participants in the sodium hypochlorite rinse group and in 35.0% of participants in the water rinse group (P < 0.05). Conclusions: An oral rinse with 0.05% sodium hypochlorite resulted in significant reductions in supragingival biofilm accumulation and gingival inflammation. Dilute sodium hypochlorite may represent an efficacious, safe and affordable antimicrobial agent in the prevention and treatment of periodontal disease.

Keywords: Sodium hypochlorite, household bleach, biofilm, plaque index, gingival index, mouth rinse, periodontal treatment

Periodontal disease and dental caries are associated with specific pathogenic bacteria harboured in oral biofilms. The successful prevention and treatment of the two major dental diseases are contingent upon the effective control of odontopathic biofilms. Basic treatment in periodontics and cariology includes the mechanical removal of dental biofilms, but mechanical treatment alone may sometimes fail to resolve odontopathic infections.

Scaling and root planing have long represented the reference standard in periodontal treatment. However, it is difficult to remove periodontopathic bacteria from deep periodontal pockets or furcation defects, and, although commercial antibiotic products for subgingival placement have become available, they are not ideal because their clinical efficacy is limited and acquisition costs are high. The drawbacks of topical antibiotic therapy include an insufficient range of antimicrobial activity for even broad-spectrum antibiotics and the risk that resistance to the antibiotic employed and to multiple drugs will develop. In addition, no antibiotic against bacteria will cover all periodontopathic species or affect periodontal viruses and yeasts.

Antiseptics attack multiple components of bacteria, viruses and yeasts, practically eliminating the risk for resistance development, and do not interact with prescription medications. Antiseptics are especially important in the treatment of biofilm infections, which may be unresponsive to even high concentrations of systemic antibiotics. Furthermore, as relatively small amounts of antimicrobial agents are applied subgingivally and the content of inflamed periodontal pockets is emptied into the oral cavity every 90 s, the risk that antiseptics might enter the gingival tissue and cause systemic damage is virtually non-existent.

Research has begun to examine the utility of low-cost antiseptic agents as adjuncts to mechanical periodontal therapy. Sodium hypochlorite has a century-long history of use as a root canal irrigant at concentrations ranging from 1.0% to 5.25%. Sodium hypochlorite rinse also exerts high antimicrobial activity against oral biofilms. Lobene et al. used college students who
were required to abstain from oral hygiene to study the clinical effects of an investigator-administered rinsing of tooth surfaces with 0.5% (5,000 ppm) sodium hypochlorite (Carrel–Dakin solution) in a water-pressure cleansing device. The sodium hypochlorite rinse produced a 47% greater reduction in the amount of dental plaque compared with the water rinse, and low pretreatment gingivitis scores were maintained around teeth rinsed in sodium hypochlorite, whereas gingivitis scores for water-rinsed sites increased by 50%.7 Lobene et al.7 also found that sodium hypochlorite rinse interfered for ≥ 24 h with the ability of dental plaque to produce acid following a sucrose challenge, which suggests a potential anti-caries effect.

As sodium hypochlorite occurs naturally in human neutrophils, monocytes and macrophages8, it does not evoke allergic reactions, is not a mutagen, carcinogen or teratogen, and has a century-long safety record9. The American Dental Association Council on Dental Therapeutics has designated 0.1% sodium hypochlorite a ‘mild antiseptic mouth rinse’ and suggested its use for direct application to mucous membranes10. Dilute sodium hypochlorite has no contraindications. Its high degree of safety permits frequent and broad usage by both dentists and patients. Sodium hypochlorite is available globally at exceptionally low cost as household bleach in concentrations of 5–6%.

The usefulness of dilute sodium hypochlorite as a mouth rinse in the treatment of periodontal disease warrants further study. The specific aim of the present study was to evaluate the effects of 0.05% sodium hypochlorite on supragingival biofilm and gingival inflammation. The study was designed as a variant of the experimental gingivitis protocol with administration a supervised twice-daily sodium hypochlorite oral rinse for 21 days.

METHODS

Study population

A total of 44 male inmates at the Men’s Prison of the Province of Formosa, Argentina were entered into the study. Study subjects were required to have at least 20 natural teeth, healthy gingiva or slight periodontitis with clinical attachment loss of ≤ 2 mm. Exclusion criteria were the use of systemic or topical antibiotic therapy within 6 months prior to the initiation of the study, the presence of systemic diseases such as diabetes, clotting disorder or human immunodeficiency virus (HIV) infection, acute necrotising gingival disease, immunosuppressive therapy or use of medications producing gingival enlargement, smoking of > 10 cigarettes/day, reduced salivary flow, current orthodontic treatment, or failure to consent to participate in the study. The study was conducted according to the protocol outlined by the Research Committee at Maimonides University and was approved by the Ethics Committee of Maimonides University School of Dentistry. The study subjects signed informed consent after the nature and the risks of the study had been thoroughly explained. The research was conducted in full accordance with the World Medical Association Declaration of Helsinki 1975 (revised in 2008).

Sodium hypochlorite

A 10% (101 g/l) sodium hypochlorite stock solution was purchased from a chemical drugstore. The 0.05% working solution was obtained by mixing 5 ml of the stock solution with 995 ml distilled water. A fresh sodium hypochlorite working solution was made every 24 h and stored in dark disposable bottles.

Study design

This study was performed as a randomised, controlled, single-blinded, clinical trial in parallel groups according to the CONSORT criteria11. Participants received periodontal treatment over a pre-experimental period of 30 days in order to establish gingival health. Study subjects underwent initially supra- and then subgingival scaling, as well as professional polishing with a rubber cup and dentifrice and interproximal cleaning using dental floss every 2 days. In addition, all individuals were enrolled in an oral hygiene motivation session, which emphasised use of the Bass tooth-brushing technique twice per day and flossing once per day. Subjects were eligible to participate in the study if ≥ 75% of all tooth sites showed absence of bleeding on probing. Shortly before the baseline examination, all subjects received dental prophylaxis to remove any remaining supragingival plaque and stain. Teeth with prosthetic restorations or non-restored dental caries were not included in the study.

Clinical assessment was based on the Quigley–Hein Plaque Index (QHPI)12 as modified by Turesky et al.13, a modified Löe and Silness Gingival Index (L&SGI) to determine visual signs of inflammation14, and the presence or absence of bleeding on probing to the bottom of the pocket, which was examined as an independent variable. Probing was carried out using a Marquis CP 12 probe at four sites at each tooth (mesiofacial, midfacial, distofacial, midlingual). Clinical photographs of the anterior teeth were used to evaluate the presence or absence of dental stain. Clinical measurements and photographs were obtained at baseline, every 7 days, and at the termination of the study on day 21. Measurements were obtained by one calibrated examiner (RDN), who was masked to the mouth rinse used by the subjects. An evaluation of intra-examiner calibration, performed in five patients, yielded an agreement of > 85%.
Treatment protocol
The study subjects were instructed to halt all oral hygiene measures for 21 days. Twenty subjects were randomly assigned to rinsing with 0.05% sodium hypochlorite and 20 to rinsing with distilled water. Subjects rinsed twice daily for 60 s with 15 ml of the assigned study solution. Rinsing was supervised by a professional dental practitioner other than the dental examiner.

Scores on the QHPI and L&SGI and the percentage of sites that bled on probing were recorded at baseline and at the termination of the study. Subjects were also monitored weekly using a questionnaire and a visual test in order to determine possible adverse drug effects on hard and soft tissues. After completing the study, the subjects received professional prophylaxis and oral hygiene reinforcement followed by topical fluoride application.

Statistical analysis
The difference between baseline and post-rinsing observations was determined for each tooth site, and the median difference was calculated for each patient. Differences between the test and control groups were analysed using the Mann–Whitney test. P-values of ≤ 0.05% were considered to indicate statistical significance.

RESULTS
Forty of the 44 enrolled subjects completed the study. Excluded from the study were three individuals who did not achieve healthy gingival status and one individual who required antibiotic medication for medical reasons during the study. The average age of the study participants was 27.8 ± 5.6 years.

Table 1 lists the key clinical findings of the study. Baseline data showed no difference between the two study groups for any of the variables evaluated. Plaque and staining were absent after the professional prophylaxis. At day 21, the average QHPI score had increased to 3.82 in the water rinse group and to 1.98 in the sodium hypochlorite rinse group; the average L&SGI score had increased to 2.1 in the water rinse group and to 1.0 in the sodium hypochlorite rinse group, and the average percentage of sites that bled on probing had increased to 93.1% in the water rinse group and to 56.7% in the sodium hypochlorite rinse group. All differences were statistically significant (P = 0.001).

Extrinsic brown tooth stains (Figure 1) appeared in 100% of the subjects in the sodium hypochlorite group and in 35.0% of the subjects in the water rinse group (P < 0.05). Stain removal was relatively easy and was often accomplished by intensive conventional oral hygiene measures. Examination of the oral mucosa revealed redness of the tongue in 35.0% (95% confidence interval [CI] 15.3–77) of subjects using sodium hypochlorite and no detectable changes in the rest of the mouth. Tooth decalcifications were not observed.

All (95% CI 83.1–100) participants in the sodium hypochlorite group reported ‘bleach taste’. A total of 85.0% (95% CI 62.1–96.8) of subjects in this group described the mouth rinse as ‘tolerable’, 15.0% (95% CI 3.2–37.9) described it as ‘moderately tolerable’ and 45.0% (95% CI 23.0–68.5) reported a burning sensation. Subjects in the sodium hypochlorite group reported a cleaner mouth and less bad breath despite not brushing their teeth for 21 days.

DISCUSSION
The present study was based on the experimental gingivitis study model15 and closely followed the design of Lobene et al.7, but involved more subjects and a longer study period. Captive populations, such as inmates or students, are ideal for investigations of investigator-administered medication but their use demands heightened ethical scrutiny by institutional review boards. All eligible inmates consented to participate in the present study.

The major finding of the study was that 0.05% sodium hypochlorite constitutes an efficacious mouth rinse in periodontal health care. Compared with the water rinse group, the sodium hypochlorite group demonstrated reductions of 48.2% in scores on the QHPI, 52.4% in scores on the L&SGI and 39.1% in the percentage of sites

Table 1 Clinical index values at days 0 and 21 in subjects using a sodium hypochlorite or distilled water oral rinse

<table>
<thead>
<tr>
<th></th>
<th>Day 0</th>
<th>Day 21</th>
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<tbody>
<tr>
<td></td>
<td>QHPI score, mean (SD)</td>
<td>L&amp;SGI score (visual assessment), mean (SD)</td>
</tr>
<tr>
<td>Sodium hypochlorite</td>
<td>0 (0)</td>
<td>0.12 (0.05)</td>
</tr>
<tr>
<td>rinse (n = 20)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Water rinse (n = 20)</td>
<td>0 (0)</td>
<td>0.08 (0.04)</td>
</tr>
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QHPI scores: 2 = a thin and continuous band of plaque (≤ 1 mm) at the cervical margin; 4 = plaque covering at ≥ 33% but ≤ 67% of the surface. L&SGI scores: 1 = mild inflammation, slight change in colour, slight oedema; 2 = moderate inflammation, redness, oedema.

*Statistically significant at P = 0.001.

SD, standard deviation; QHPI, Quigley–Hein Plaque Index; L&SGI, Löe and Silness Gingival Index.
that bled on probing. Lobene et al.\(^7\) found 47% greater plaque reduction with sodium hypochlorite irrigation than with water rinsing. The present study was performed without concomitant tooth-brushing. As sodium hypochlorite exerts a unique anti-biofilm effect by loosening the attachment of microorganisms to solid surfaces\(^{16}\), tooth-brushing following a sodium hypochlorite rinse may further enhance plaque removal and increase the difference between outcomes in the two subject groups in this study.

Post-treatment, the mean L&SGI score was 1.0 and the percentage of sites that bled on probing averaged 56.7% in the sodium hypochlorite group. According to the L&SGI\(^{14}\), scores of 0 or 1 are not associated with gingival bleeding, but a score of 2 is. However, when we examined visual GI scores and sites of bleeding on probing independently, we found that 17.1% of sites with a visual GI score of 0 bled on probing, 42.3% of sites with a visual GI score of 1 bled on probing, and 5.7% of sites with a visual GI score of 2 did not bleed on probing\(^{17}\). Apparently, visual signs of gingival inflammation and bleeding on probing may not be as tightly correlated or constitute as straightforward a continuum as implied in the L&SGI\(^{14}\).

The brown extrinsic tooth stain observed after sodium hypochlorite rinsing has also been reported after the use of other oral antiseptics, including chlorhexidine\(^{18}\) and hexetidine\(^{19}\). All subjects receiving sodium hypochlorite rinse demonstrated a brownish stain at the end of the study, but 35.0% of subjects in the water rinse group also exhibited brown tooth staining, although of a lower magnitude. The discoloration of the teeth may stem from chromogenic products in food or beverages\(^{20}\) or from overgrowth of non-periodontopathic Actinomyces species\(^{21}\). The sodium hypochlorite-associated stain was relatively easy to remove, which contrasts with the tooth stain related to chlorhexidine. Research has still to identify the composition of antiseptic-associated tooth stains and methods to minimise or prevent their development.

Sodium hypochlorite was tested at a concentration of 0.05% and applied as a mouth rinse for 60 s twice per day. Preliminary taste tests in our clinics showed that a sodium hypochlorite concentration of 0.05% was generally well tolerated. A 0.05% sodium hypochlorite concentration is five times above the minimal antibacterial concentration of 0.01%\(^{22}\), but 10 times lower than the 0.5% concentration used for supragingival irrigation by Lobene et al.\(^7\) and four times lower than a newly
recommended mouth rinse containing 0.2% sodium hypochlorite to be used for 30 s two or three times per week. The protocol of the present study resulted in approximately three times as much exposure to sodium hypochlorite as the application of 0.2% sodium hypochlorite for 30 s two or three times per week. Further studies are needed to determine if low concentrations but frequent use of sodium hypochlorite will yield levels of biofilm removal and tooth staining similar to those afforded by a higher concentration of sodium hypochlorite and less frequent rinsing. Factors of importance in terms of patient compliance include the provision of a less objectionable taste and a reduction in the required frequency of usage, but it may be difficult to achieve both of these objectives simultaneously.

Sodium hypochlorite, which is widely available as household bleach, can benefit all periodontal patients, but its low price makes it particularly suitable for individuals with low incomes. In 2008, the World Bank estimated that 1.4 billion people in 115 low-income countries lived in extreme poverty as measured by the poverty line defined by a purchasing power of US$1.25/day. Low-income individuals are at elevated risk for developing periodontal disease and are unable to afford many dental self-care products, and thus the need to implement efficacious and low-cost periodontal health care in many parts of the world is urgent. We suggest that dilute sodium hypochlorite can serve as a useful antimicrobial agent in the prevention and treatment of most types of periodontal disease.

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Conflicts of interest

None declared.

REFERENCES


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