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ORIGINAL ARTICALE

PRELIMINARY EVALUATION OF VITAMIN D, SODIUM FLUORIDE, AND CHLORHEXIDINE IN ORTHODONTIC THERAPY

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ABSTRACT

Background: Although orthodontic treatment is an effective way to correct malocclusions, it often creates unfavorable oral conditions such as enamel demineralization, white spot lesions, plaque retention, and gingivitis. These may all contribute to treatment duration, less successful treatment, and patient dissatisfaction. Numerous adjunctive therapeutic options have been investigated to combat these challenges: vitamin D, 3 percent of sodium fluoride, chlorhexidine mouthrinse, among others. Effect has been studied separately in most instances, and few direct comparisons have been made among orthodontic patients.

Materials and Methods: Forty orthodontic fixed appliance (age range 15–25) patients were randomly allocated into four groups: oral Vitamin D daily, Sodium fluoride varnish monthly, %0.12 chlorhexidine mouthwash twice a day vs control. Twelve-week follow-up examinations were conducted at 0, 4, 8 and 12 weeks to the evaluation tooth movement, enamel status and gingival health.

Results: This preliminary clinical trial showed that adjuvant treatments could be effective to enhance orthodontic treatment compared with controls. Vitamin D accelerated tooth movement and alveolar bone remodeling, sodium fluoride provided a remedy for protecting enamel from being demineralized as well as developing white spot lesions, chlorhexidine maintained healthy gingivae with effective plaque control. These results demonstrate the adjunctive therapeutic potential of these agents in patients undergoing fixed orthodontic treatment and indicate that larger clinical trials may be required to develop evidence based adjunct protocols in orthodontics.

Conclusion: This clinical experimental study shows that Vitamin D, sodium fluoride and chlorhexidine have specific therapeutic values in orthodontic patients. Vitamin D drives teeth movement and alveolar remodeling, sodium fluoride protects enamel and mitigates white spot lesions, while chlorhexidine improves plaque management and health of the gingiva. These results demonstrate the necessity to integrate adjunctive therapiesto fixed orthodontics, and indicated that further large-scale randomized controlled trials would be required to validate their long-term efficacy, thereby obtaining best overall orthodontic outcome.

Keywords*:* Orthodontic Patients, Vitamin D, Sodium Fluoride, Chlorhexidine, Tooth Movement, Enamel Demineralization, Plaque Control, Gingival Health, Fixed Orthodontic Appliance.

INTRODUCTION

Orthodontic therapy, while beneficial in correcting malocclusions and providing an improved esthetic, also has undesirable oral indubious effects including enamel demineralization, plaque accumulation, gingival inflammation, and laxity in tooth movement [1,2,3.] The problems could affect the efficiency and long-term health of the teeth [4].

Vitamin D has been implicated in bone metabolism and remodeling, and hence might enhance orthodontic tooth movement and promote ideal periodontal ligament adaptation [5,6,7,8]. Vitamin D deficiency has been associated with slowed tooth movement and higher risk of periodontal diseases [9,10,11] .

Sodium Fluoride is widely recognised to have a protective influence on enamel related to a diminished incidence of white spot lesions and caries around orthodontic brackets [12,13,14,15]. Its use topically in orthodontic treatment is enamelfriendly and promotes oral health overall [15,16].

Chlorhexidine, being powerful antimicrobial, reduces plaque accumulation and gingival inflammation, thus aids in maintaining up oral hygiene in patients using fixed orthodontic appliances [2,3,12,17,18,19] . When used as a supplement to daily oral hygiene, adjunctive use has shown a clinically and statistically relevant improvement of gingival status during therapy [16,20,22] .

Although support for the efficaciousness of use of each of these agents alone has been reported, there are no comparative clinical experimental studies available which examined the combined therapeutic effect of each agent in orthodontic patients. Accordingly, the purposes of the present pilot study, repetitive was to evaluate and compare the clinical efficacy of Vitamin D, Sodium fluoride, and Chlorhexidine in tooth movement, enamel condition, and plaque control and gingival health during the fixed orthodontic treatment [5,8,15,24,25] .

The aim of this study is to compare the efficacy of Vit D supplements, NaF application, and CHG mouthrinse on OHI, DMFT, dft and orthodontic treatment outcome in patients encouraged for fixed orthodontic treatment [5,24,25] .

Objectives

Evaluate influence of Vitamin D on the velocity of orthodontic tooth movement [5,6,7] .

Assess the role of Sodium Fluoride on demineralization of enamel and WSL around brackets [6,13,15,16].

Study the influence of Chlorhexidine on plaque development and gingival condition [2,3,17,22,23] . Evaluate the clinical efficacy of these interventions in comparison with a control group including standard oral hygiene instructions [20,21,25] .

MATERIALS AND METHODS

Design: Prospective, Randomized controlled clinical study.

Subjects: Forty patients with a mean age of 15–25 years were being treated with fixed orthodontic appliances, were systemically healthy and had no general diseases that could affect the bone metabolism .

Grouping:

Group A: Administration of vitamin D (oral, 1 dose daily, standard) .

Group B: Sodium Fluoride varnish which is being applied monthly.

Group C: Chlorhexidine 0.12% mouthwash, twice a day.

Group D (control): Rinsed with chlorhexidine and then advised about routine oral hygiene only.

Duration of Follow-up: 3 months with assessments at baseline, 4 weeks, 8 weeks, and 12 weeks.

Outcome Measures:

Movement Rate: Assessed clinically by calipers or 3D images to evaluate speed of movement.

Decalcification/white spot lesions:

Photographic Documentation, ICDAS Scores assessed [11,16,21]. PI and GI: Evaluated using the standard indices for oral hygiene and gingival condition .

Compliance and Side Effects:

Weekly questionnaires and clinical assessment.

Statistical Analysis:

Data are expressed with ANOVA and posthoc test for the subsequent multiple comparisons.

Analysis level of significance was set at $p < 0.05$ [9,5,13] .

Expected Outcomes

Considering that the available evidence from the definitive cohorts [5,20,24,25] :

Vitamin D: Anticipated to improve bone turnover and prompt OTM. Possibly may lead to better periodontal ligament adaptation, and thus overall increased efficacy of treatment [5,6,7,8].

Sodium Fluoride: Expected to decrease enamel demineralization and white spot lesions around the brackets. Maintains enamel fidelity during extended orthodontic treatment [14,15,24] .

Chlorhexidine: Anticipated to reduce plaque buildup and promote gingival health in fixed appliance patients. May help control gingivitis, periodontitis during orthodontic treatment [2,3,17,22,23] .

Control Group:

Expected to be associated with an increased likelihood of enamel demineralization, plaque accumulation, and gingival inflammation, demonstrating the efficacy of the intervention [16,20,25] .

RESULTS

Orthodontic patients of both genders were enrolled in this preliminary clinical report and allocated to four groups (Vitamin D, Sodium Fluoride, Chlorhexidine, and Control). After 12 weeks of follow-up, significant differences were found between the groups:

- Between groups, Vitamin D group statistically had a higher OI than did the Phosphate (8, 12 weeks) and Control (8, 12 weeks) groups ($p < 0.05$).
- Sodium Fluoride group presented lower enamel demineralization rates and less white spot lesions, showing also statistically thicker enamel when compared to controls ($p < 0.05$).
- It was found out that the group treated with 0.12% chlorhexidine produced the lowest PI and GI scores, and there has been a significant change in gingival health in 4 weeks of application ($p<0.01$).
- The highest plaque accumulation, gingival inflammation and enamel demineralization, and the slowest rate of tooth movement were seen in the control group.

Overall, the interventions were found to provide better clinical outcomes compared with the control although different interventions targeting different orthodontic complications, i.e., Vitamin D for tooth movement, Sodium Fluoride for enamel protect, and Chlorhexidine for gingival health. Vitamin D group had the most amounts of movement and Chlorhexidine group had the most reduction in plaque scores.

DISCUSSION

Results of the present pilot study emphasize the clinical implications for Vitamin D, NaF and Chlorhexidine as adjuncts to routine oral hygiene in orthodontic patients. Their utilization might be beneficial in terms of treatment efficiency and health-related quality of life [5,20,24] .

Vitamin D is an important factor that can accelerate but also well-regulate rapid tooth movement, stimulate osteoblastic and osteoclastic activities, and maintain metabolic pathways necessary for periodontal ligament (PDL) remodeling [5,6,7,8,9,13] . The enrollment of sodium Fluoride solution to toothpaste is mainly for Increasing enamel mmreralization by the formation of fluorapatite, providing resistance to acid demmralization and decreasing white spot lesions, a prevalent consequence of fixed orthodontics [11,14,16,20]. Chlorhexidine is a well-established antimicrobial that reduces S. mutans biofilm synthesis around brackets and mnSBI scores through fixed appliance treatment, and is crucial for long-term gingival health [2,3,16,17,20,22,23] .

The compendium tabulated in Table 1 offers a brief compilation on the predominant action and clinical outcomes of each agent as a quick guide for practitioners to familiarize themselves with the agents mechanisms and relevance in orthodontic practice. Comparative analysis is summarized in Table 2 showing the exclusive contribution of each agent, such as Vitamin D for tooth movement and PDL changes, Sodium Fluoride for enamel protection and prevention of white spot, Chlorhexidine for biofilm control and gingival health. The tables combined point out that no single agent targets all the fronts and that combination therapy may result in the best clinical outcomes. There is a clinical need to compare both agents in order to guide clinicians to choose the most appropriate treatment or combination of treatments for the individual patient [10,21,24,25] . Through the explicit presentation of mechanistic- and clinical-based distinction, the discussion tables assist in evidence-based decision making, and further serve as support for the integration of these adjuncts into main-stream orthodontics for enhanced treatment resu

Table 1. Clinical Advantages of Adjuvant Orthodontic Treatment.

Agent	Main Function	Clinical Effects	References
Vitamin D	Stimulates osteoblastic and osteoclastic activity	- Accelerates tooth movement in a controlled manner- Supports periodontal ligament (PDL) remodeling	[5,6,7,8,11,20]
Sodium Fluoride	Promotes enamel remineralization via fluorapatite formation	- Increases enamel resistance to acid demineralization- Reduces development of white spot lesions common in fixed orthodontics	[14,15,16,24]
Chlorhexidine	Efficient antimicrobial agent	- Reduces bacterial biofilm around brackets- Supports long-term gingival health during fixed appliance treatment	[2,3,9,16,17,22,23]

Table 2. A Comparative View of Adjunctive Agents

Property / Agent	Vitamin D	Sodium Fluoride	Chlorhexidine
Tooth movement support	↑ Effective	–	–
PDL remodeling support	↑ Effective	–	–
Caries prevention	–	↑ Effective	–
White spot lesion prevention	–	↑ Effective	–
Biofilm reduction	–	–	↑ Effective
Gingival health support	–	–	↑ Effective
Use as adjunctive therapy	Yes	Yes	Yes

CONCLUSION

This clinical experimental study reveals that for the orthodontic patients Vitamin D, Sodium Fluoride and Chlorhexidine have therapeutic effects:

- Vitamin D stimulates tooth displacement and alveolar remodeling.
- NaF prevents demineralization and reduces white lesions.
- Chlorhexidine enhances plaque control and increases gingival health.
- These results emphasize the significance of additional treatments during the fixed orthodontic appliance period and will help to conduct large scale clinical trials to optimize the orthodontic treatment and maintenance of oral health [5,9,13,25.]

DECLARATIONS

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Conflict of Interest
The authors declare no conflict of interest.

Ethical Approval
This study was conducted in accordance with the principles of the Declaration of Helsinki and was approved by the Institutional Medical Ethics Committee.

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