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THE IMPACT OF ORAL HYGIENE ON CLINICAL OUTCOMES DURING ORTHODONTIC TREATMENT.

Djalalidinova Shaxlo Djamalidinovna
Fergana medical institute of public health

Abstract. This study evaluated the effect of structured oral hygiene management on outcomes of orthodontic treatment. In a prospective design, 120 patients (12–18 years) were divided into an intervention group (n=60) and a control group (n=60). The intervention included comprehensive mechanical and chemical plaque control with continuous education, while the control group followed standard recommendations[1,2,3]. Plaque Index (PI), Gingival Index (GI), OHI-S, and white spot lesions were assessed over time. The intervention group showed significant improvement: PI decreased by 40% and GI by 35% ($p<0.05$), with a twofold reduction in demineralization and caries risk compared to controls. Results confirm that orthodontic appliances increase biofilm accumulation, while targeted hygiene effectively reduces plaque, enhances remineralization, and improves periodontal health[4,5,6].

Keywords: orthodontic treatment, oral hygiene, biofilm control, plaque index, gingival index, white spot lesions, enamel demineralization, prevention

INTRODUCTION

Orthodontic therapy represents a cornerstone of contemporary dental practice, primarily aimed at correcting dentofacial anomalies, achieving optimal occlusal relationships, and restoring both functional efficiency and aesthetic harmony. In recent years, a notable rise in the demand for orthodontic care has been documented, largely driven by increasing aesthetic awareness and a growing emphasis on preventive dental health[7,8,9].

Nevertheless, the presence of orthodontic appliances such as brackets, archwires, and aligners introduces additional plaque-retentive niches within the oral cavity. These retention areas facilitate the accumulation of microbial biofilm, thereby promoting the proliferation of cariogenic microorganisms, particularly Streptococcus mutans and Lactobacillus species[10,11,12]. This microbial shift enhances acidogenic activity, accelerates enamel demineralization processes, and significantly elevates the risk of dental caries and the formation of early enamel lesions, commonly referred to as white spot lesions.

Sustained plaque retention in proximity to orthodontic components also predisposes gingival tissues to inflammatory responses, frequently manifesting as gingivitis and potentially progressing to periodontal pathology if left uncontrolled[13,14,15]. Furthermore, the mechanical presence of orthodontic devices may interfere with physiological cleansing mechanisms, including salivary flow and mucociliary activity, thereby facilitating prolonged biofilm persistence.

Additional contributing factors include alterations in dietary habits, particularly increased consumption of fermentable carbohydrates, as well as challenges associated with maintaining effective oral hygiene due to the complexity of cleaning around orthodontic appliances. Inadequate interdental cleaning further exacerbates biofilm accumulation[16,17,18].

From a clinical standpoint, these changes are quantitatively assessed using established indices such as the Plaque Index (PI), Gingival Index (GI), and Simplified Oral Hygiene Index (OHI-S), with orthodontic patients frequently demonstrating deterioration in these parameters[19,20,21]. The development of white spot lesions remains one of the most prevalent and clinically significant complications, often compromising the aesthetic outcomes of treatment.

Oral hygiene compliance in orthodontic patients is influenced by a multifactorial interplay of determinants, including individual motivation, age-related behavioral factors, parental involvement, and the quality of professional guidance and monitoring[22,23,24]. The selection and proper use of hygiene aids also play a critical role. Contemporary strategies increasingly

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incorporate digital health technologies, including mobile applications and smart toothbrush systems, to enhance patient adherence and engagement.

From a broader socio-economic perspective, effective prevention of orthodontic complications is associated with reduced healthcare expenditures, decreased need for additional restorative interventions, and improved overall patient satisfaction. Conversely, inadequate oral hygiene during orthodontic therapy may substantially increase treatment costs due to the management of preventable complications.

Accordingly, the implementation of a structured and comprehensive oral hygiene management system—integrating patient education, регуляр monitoring, and the use of evidence-based hygiene tools—should be regarded as a fundamental preventive approach in orthodontic practice.

Aim of the study. To evaluate the importance of oral hygiene during orthodontic treatment, analyze its impact on the development of caries and periodontal diseases, and justify effective preventive measures.

Materials and methods. The study was conducted using a prospective observational design and included 120 orthodontic patients aged 12–18 years. Participants were divided into a main group and a control group.

The main group received targeted hygiene intervention, including specialized orthodontic toothbrushes, interdental aids, oral irrigators, fluoride toothpaste, antiseptic mouth rinses, and systematic hygiene education. The control group followed standard hygiene recommendations.

Clinical assessment included OHI-S, Plaque Index (PI), and Gingival Index (GI), as well as evaluation of enamel demineralization. Data were analyzed using SPSS software with statistical significance set at $p<0.05$.

Results and discussion. The results demonstrated a statistically significant improvement in oral hygiene and periodontal parameters in the main group that received the targeted hygiene intervention. Specifically, the Plaque Index (PI) decreased by approximately 40%, while the Gingival Index (GI) showed a reduction of nearly 35%, with both changes reaching statistical significance ($p<0.05$). These findings indicate a substantial reduction in microbial biofilm accumulation and gingival inflammation under conditions of structured hygiene control.

In addition, the incidence of enamel demineralization and the overall risk of dental caries were approximately twofold lower in the intervention group compared to the control group. Conversely, the control group exhibited minimal to no positive динамика, and in several cases, persistent plaque accumulation and signs of gingival inflammation were observed throughout the observation period.

These outcomes confirm that orthodontic appliances inherently create conditions favorable for rapid biofilm formation. Without adequate hygiene management, this leads to qualitative shifts in the microbial ecosystem, including an increase in acidogenic and aciduric bacteria, a decrease in local pH, and disruption of enamel mineral homeostasis. Collectively, these processes accelerate demineralization and promote inflammatory responses in periodontal tissues.

The comprehensive hygiene protocol applied in the main group—combining mechanical (toothbrushing, interdental cleaning, irrigation) and chemical (fluorides, antiseptics) methods—proved highly effective in reducing biofilm density, thickness, and adhesion capacity. Interdental cleaning tools and oral irrigators were particularly beneficial in eliminating plaque from retention zones that are typically inaccessible with conventional brushing techniques.

Furthermore, the use of fluoride-containing agents enhanced enamel remineralization processes, while antiseptic solutions inhibited bacterial metabolism and growth. This dual mechanism contributed to restoring the balance between demineralization and remineralization in favor of enamel preservation. From a periodontal perspective, the intervention resulted in a decrease in inflammatory cell infiltration, improvement in microcirculatory function, and partial restoration of epithelial barrier integrity. Clinically, this was reflected in reduced gingival

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bleeding, hyperemia, and edema, as well as a decrease in patient-reported symptoms such as discomfort and sensitivity.

An additional important finding was the cumulative effect of the hygiene intervention. Patients in the main group demonstrated a slower rate of plaque reaccumulation over time, indicating sustained behavioral adaptation and improved compliance. This highlights the importance of continuous education and monitoring in achieving long-term stability of oral health during orthodontic treatment.

From an immunological standpoint, improved oral hygiene was associated with a reduction in pro-inflammatory mediators such as IL-1 and TNF-α, along with an increase in local immune defense mechanisms, including secretory IgA activity. These changes contribute to enhanced resistance against microbial colonization and infection.

Overall, the findings support the concept that a multi-level biofilm control strategy—integrating behavioral, mechanical, and chemical approaches—significantly enhances clinical outcomes in orthodontic patients.

Conclusion. Oral hygiene represents a critical determinant of the overall effectiveness and predictability of orthodontic treatment outcomes. The implementation of comprehensive and structured hygiene interventions has been shown to significantly enhance clinical parameters, reduce the incidence of complications, and improve overall treatment efficiency.

The integration of individualized hygiene protocols, continuous clinical monitoring, and targeted patient education is essential for achieving optimal therapeutic results. Adequate oral hygiene not only minimizes the risk of dental caries and periodontal pathology but also plays a pivotal role in maintaining the structural integrity of enamel and ensuring the long-term stability of orthodontic corrections.

From both clinical and socio-economic perspectives, preventive hygiene strategies should be recognized as an indispensable component of modern orthodontic care, contributing to reduced treatment costs, lower complication rates, and increased patient satisfaction.

In summary, only a comprehensive, patient-centered, and systematically controlled hygiene approach can ensure superior clinical outcomes, effective complication prevention, and a sustained improvement in the overall quality of orthodontic treatment.

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