

## **Periodontal Implications of Orthodontic Treatment: Assessment of The Balance between Tooth Movement and Surrounding Tissue**

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**Abstract.** Orthodontic treatment also aims to maintain ideal periodontal health. Gingival/periodontal conditions and orthodontic interventions have a complicated relationship because orthodontic forces invariably affect periodontal structures. The aims of this study were to investigate the plaque, and gingival index, before and during orthodontic treatment. In order to fully evaluate the periodontal health of orthodontic patients, a study spanning six months was carried out of 100 adult permanent dentition subjects were included in the sample. Participants were recruited from a specialized orthodontic clinic, and OPI, and OGI were assessed at multiple time points: baseline, 3 months, and 6 months post-treatment initiation. The study found that there were significant increasing in orthodontic plaque index, and orthodontic gingival index before orthodontic appliance insertion and over 6 months of post treatment. This study highlights the significant impact of orthodontic appliances on both gingival health and plaque accumulation. The increase in the Orthodontic Gingival Index and Orthodontic Plaque Index during treatment emphasizes the need for effective oral hygiene strategies for patients undergoing orthodontic therapy. Future research should focus on developing innovative methods to help orthodontic patients improve their oral hygiene practices and prevent gingival inflammation and plaque accumulation.

### **Highlights:**

1. Orthodontic treatment led to significant increases in gingival inflammation and plaque accumulation over six months.
2. Both Orthodontic Gingival Index (OGI) and Orthodontic Plaque Index (OPI) showed steady rises from baseline to 6 months.
3. Findings emphasize the need for strict oral hygiene strategies during orthodontic therapy to prevent periodontal complications.

**Keywords:** Orthodontic treatment, Gingival Index, Plaque Index, Fixed appliances, Plaque accumulation, Gingival inflammation, Oral hygiene.

## **Introduction**

Orthodontic treatment has long been recognized for its ability to correct malocclusions, align teeth, and improve both the function and aesthetics of a patient's dentition. The primary objective of orthodontics is to reposition teeth in a way that enhances occlusion, facilitates improved oral hygiene, and minimizes the risk of future dental issues. However, as with any

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form of dental intervention, orthodontic treatment carries potential implications for the surrounding tissues, especially the periodontium. Periodontal health, which includes the gums, periodontal ligaments, cementum, and alveolar bone, plays a vital role in maintaining the stability and long-term success of orthodontic outcomes [1].

The interplay between tooth movement and the surrounding periodontal tissues is a complex and dynamic process that involves biomechanical, biological, and physiological factors [2]. Orthodontic forces, when applied to teeth, initiate a cascade of events that influence the periodontal structures. These forces result in the remodeling of the alveolar bone and alteration of the periodontal ligament (PDL), facilitating tooth movement. However, inappropriate force levels, inadequate technique, or pre-existing periodontal issues can disrupt the delicate balance between tooth movement and tissue health, leading to potential complications such as root resorption, loss of attachment, gingival recession, or even tooth mobility[3].

The effectiveness of orthodontic treatment in achieving desired outcomes must be assessed not only by the alignment of teeth but also by the health and stability of the surrounding periodontal tissues [4]. The long-term success of orthodontic treatment is contingent upon maintaining this balance between tooth movement and the integrity of the periodontium[5]. It is essential to consider the factors that affect the periodontal tissues during orthodontic therapy, such as the magnitude, duration, and direction of the applied forces, as well as the individual's periodontal condition prior to treatment.

## **Materials Methods**

This research utilized a longitudinal study design, which involved following 100 patients undergoing fixed orthodontic treatment over a period of 6 months. Participants were recruited from a specialized orthodontic clinic, and Orthodontic Plaque index (OPI), and Orthodontic Gingival Index (OGI) were assessed at multiple time points: baseline, 3 months, and 6 months post-treatment initiation.

### **Inclusion Criteria**

1. Age 15-25 years
2. Normal breathing
3. No previous history of periodontal diseases
4. No medical history of systemic diseases
5. No craniofacial anomalies
6. All patients were used fluoride toothpaste

### **Exclusion criteria**

1. Patient cannot come to the dental center regularly
2. Patients extracted teeth before treatment
3. Patients used toothpaste rather than fluoride containing
4. Patients smoking cigarettes
5. Patients drinking alcohol

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## Sample size calculation

A total of 100 participant were included in this study. The sample size was calculated by using G\*Power (version 3.1.9.6) free software, the alpha level was set as 0.05 and the power was set 8%, and the effect size was (0.5).

## Data Collection

The procedure was carried out at the day of appliance placement, after 3-months, and 6-months post treatment. The participants underwent complete oral examination and oral hygiene maintenance instruction was given to the patients before and during orthodontic treatment.

Two primary clinical measures were used to assess oral health:

**Orthodontic Gingival Index (OGI):** The OGI evaluates the degree of gingival inflammation, including signs of redness, swelling, and bleeding upon probing [6]. Each tooth was examined for gingival health, and scores were assigned as follows:

0: Healthy gingiva

1: Mild inflammation, no bleeding

2: Moderate inflammation, bleeding on probing

3: Severe inflammation, spontaneous bleeding

**Orthodontic Plaque Index (OPI):** The OPI measures the amount of plaque accumulation around orthodontic appliances [7]. Plaque was evaluated on each tooth, and scores were assigned as follows:

0: No plaque deposits on the tooth surfaces surrounding the bracket base

- 1: Plaque deposits on one tooth surface at the bracket base
- 2: Plaque deposits on two tooth surfaces at the bracket base
- 3: Plaque deposits on three tooth surfaces at the bracket base
- 4: Plaque deposits on four tooth surfaces at the bracket base and/or gingival inflammation indicators (plaque deposits near the gingiva do not necessarily have to be present)

The examination of 6 teeth included upper right 1<sup>st</sup> molar, lower left 1<sup>st</sup> molar, lower right lateral, lower left lateral, upper left first premolar, and upper right first premolar for plaque and gingival index, and the anterior teeth for enamel decalcification index.

The dentist instructs the patients to brush their teeth two times a day, and after remove the appliance the orthodontist clean the teeth from resin of bracket bonding.

## statistical Analysis

Data were analyzed using descriptive statistics (mean, standard deviation) to summarize the changes in OGI and OPI over time. Paired t-tests were used to compare the indices at each follow-up visit with baseline values. A p-value of less than 0.05 was considered

statistically significant. Correlations between the increase in indices and factors such as age, gender, and treatment duration were also assessed using Pearson's correlation coefficient.

## Result

A total of 100 patients were enrolled in the study, with 60 females and 40 males. The average age of participants was  $16.8 \pm 3.2$  years. The majority of patients were receiving treatment for malocclusions such as crowding (45%), overbite (35%), and open bite (20%).

At baseline, the mean OGI score was  $1.2 \pm 0.3$ , indicating healthy gingiva with minimal inflammation. However, at the 3-month follow-up, the mean OGI increased significantly, and this was attributed to the difficulty of cleaning around the brackets, which led to the early signs of gingival inflammation. At the 6-month follow-up, the OGI score further increased to showing moderate gingival inflammation in many patients (table 1).

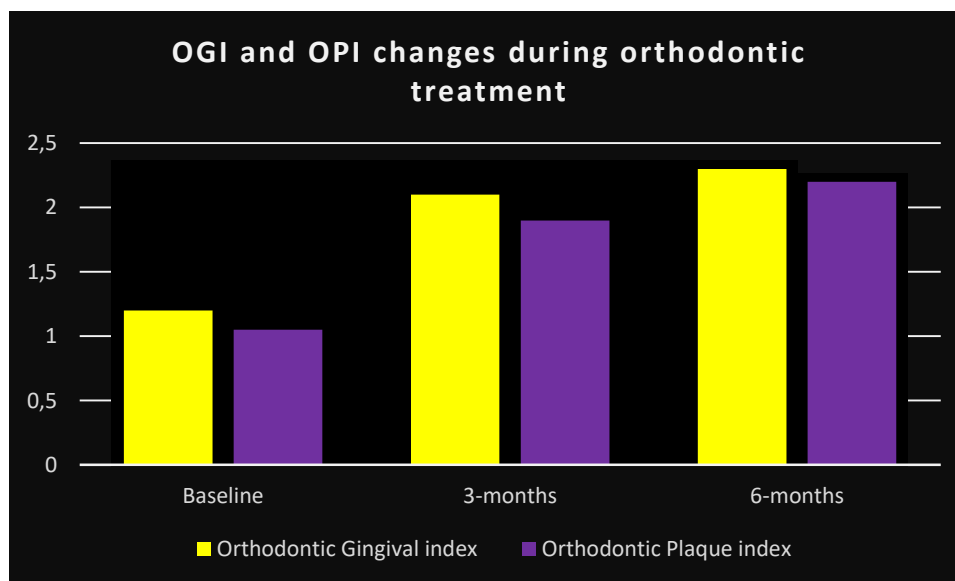
Similarly, the mean OPI score at baseline was  $1.5 \pm 0.4$ , indicating mild plaque accumulation around the teeth. At the 3-month follow-up, the mean OPI score increased significantly, and this is reflecting the accumulation of plaque in hard-to-reach areas. By the 6-month follow-up, the OPI score increased to show a significant plaque accumulation around the orthodontic appliances (table 1). There were significant increasing over the 6-months study period. The significant differences of results ( $P=0.001$  and  $0.004$  for gingival and plaque indices respectively) confirms that these increasing in plaque index and lead to increasing gingival inflammation.

**Table 1:** Changes in the Orthodontic Gingival Index and Orthodontic Plaque index during orthodontic treatment

Indices		Mean $\pm$ SD		
Time interval	Baseline	3-months	6-months	$P^*$
				value
Orthodontic	$1.2 \pm 0.3$	$2.1 \pm 0.5$	$2.3 \pm 0.6$	$0.001^*$
Gingival index				

Orthodontic 1.05±0.4 1.9±0.3 2.2±0.7 0.003\*

Plaque index



**Figure 1:** Changes in the Orthodontic Gingival Index and Orthodontic Plaque index during orthodontic treatment

## Discussion

The purpose of this study was to assess how orthodontic patients's gingival inflammation and plaque accumulation in orthodontic patients over a six- months period. The study included 100 participants, 60 of whom were female and 40 oh whom were male. These patients' malocclusion, which included crowding (45%), overbite (35%), and open bite (20%), were the main cause of their orthodontic treatment. Given the high rate of malocclusion, this group is typical of one that would seek orthodontic treatment. The results of this study offer important light on the relationship between orthodontic appliances and oral health, especially with regard to gingival inflammation and plaque accumulation, two issues that are frequently raised in orthodontic treatment.

The mean of OGI score at baseline was 1.2±0.3 which indicates low inflammation and healthy gingiva. This is a good score to start because it shows that the participants 'gingival and oral hygiene were generally in good condition before orthodontic treatment began.

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However, notable alterations in gingival health were noted as the study progress. The initiation of gingival inflammation was reflected in the considerable increase in the mean of OGI score at the 3-months follow up[8]. The difficulty of cleaning around orthodontic brackets, which produce many regions that are difficult to reach with conventional tooth brushing procedures, is the cause of this increasing [9]. Plaque tends to gather more readily around the brackets and archwire as a result, creating an environment that is conducive to the growth of bacteria that cause gingival inflammation [10].

The OGI score increased further by the 6 months follow up, indicating moderate gingival inflammation in many patients, which is consistent with other studies that have found that gingival inflammation often gets worse over time during orthodontic treatment [11]. The presence of orthodontic appliances, like brackets and archwires, makes it harder for patients to maintain proper oral hygiene, which leads to plaque accumulation, which in turn causes gingival inflammation [12]. Studies have shown that patients undergoing orthodontic treatment are more likely to develop gingivitis because the mechanical challenges caused by appliance[13]. This is a serious concern because untreated gingival diseases can lead to severe periodontal diseases such as periodontitis[14].

In order to prevent progression of inflammation to more severe periodontal diseases, orthodontic patients should be instructed the importance of maintaining good oral hygiene throughout treatment, as evidenced by the increase in gingival inflammation reported at 3-months and 6-months follow up.

There was a mild accumulation of plaque around the teeth, and this showed a considerable increasing during the 6 months follow-up. This increasing is a result of orthodontic patients difficulties maintaining their oral hygiene, especially around the brackets and archwires. For patients with fixed orthodontic appliances, the plaque accumulation is frequent in area that hard to reach, such as between teeth and the gum line[15]. These regions need extra care, including using interdental brushes, floss, or water flossers, because they are frequently not sufficiently cleaned by regular brushing[16].

Plaque is the main source of gingival irritation and, if ignored, can result in more severe symptoms like cavities or periodontal disease, so this increasing in plaque levels is alarming[17]. The necessity for better oral hygiene practices in orthodontic patients is highlighted by the notable increase in plaque accumulation over a six-month period[18]. This is because standard brushing may not be enough to avoid plaque development around appliances[16].

Though orthodontic patients are likely to accumulate plaque, particularly in the early stages of treatment, it is crucial to stress the long-term effects of poor plaque control[19]. Poor plaque management during orthodontic treatment has been shown to cause irreparable harm to the teeth and the soft tissues around them. The results of the study demonstrate the significance of routine professional cleanings and follow-ups throughout orthodontic treatment, as well as the vital function that oral hygiene education productions[20].

The increased gingival inflammation and plaque formation seen in this study are caused by a number of generates. The main contributing factor is the use of orthodontic appliances,

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which erect physical obstacles to efficient brushing and flossing. Plaque removal is made more difficult by the brackets and wires, which block access to the tooth surfaces[21]. Furthermore, patients could find it difficult to brush around the brackets correctly, which could result in inefficient plaque removal. The challenge of maintaining regular and efficient oral hygiene practices while undergoing orthodontic treatment is another significant factor. Due to their wild schedules, adolescents and young adults frequently disregard their dental hygiene, which can result in accumulation of plaque[22].

The results of this study have important significance for managing oral hygiene and orthodontic therapy. Orthodontists and other dental professionals must be proactive in teaching patients about the need of maintaining good oral hygiene during treatment since orthodontic patients are more likely to have gingival irritation and plaque accumulation. This entails giving patients detailed instructions on how to properly clean the region surrounding their brackets and wires and advising them to use supplemental instruments like mouthwashes, floss threaders, and interdental brushes to assist remove plaque from difficult-to-reach places.

Additionally, to assist stop the advancement of plaque accumulation and gingival irritation, routine professional cleanings and follow-up visits are essential. Orthodontists should evaluate their patients' dental hygiene on a regular basis and take prompt action if they see any indications of irritation or plaque accumulation[23]. During therapy, encouraging patients to use mouthwashes and toothpaste containing fluoride may also help to strengthen their teeth and maintain oral hygiene.

## Conclusion

This study highlights the significant impact of orthodontic appliances on both gingival health and plaque accumulation. The increase in the Orthodontic Gingival Index and Orthodontic Plaque Index during treatment emphasizes the need for effective oral hygiene strategies for patients undergoing orthodontic therapy. Future research should focus on developing innovative methods to help orthodontic patients improve their oral hygiene practices and prevent gingival inflammation and plaque accumulation.

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