

WEST AFRICAN JOURNAL OF ORTHODONTICS

VOLUME 14, NUMBER 2

ISSN 2315-9502

December 2025

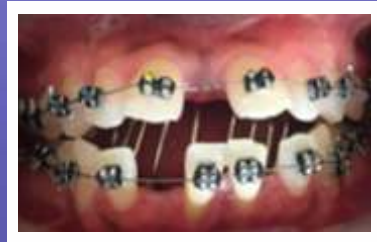
**Cephalometric analysis using a
mobile application**



**Complications associated with
orthodontic treatment**



**Case Report: Management of
Class III malocclusion**



**Abstracts presented at NAO 2025
Annual Scientific Conference**



A Three-Year Review of Complications associated with Orthodontic Treatment in A Nigerian Teaching Hospital

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Abstract

Background: Orthodontic interventions, though effective in correcting malocclusions, can lead to undesirable oral complications that may affect treatment efficiency and patient comfort. Therefore, this study aimed to document complications occurring during and shortly after orthodontic management and the treatment duration with fixed or removable appliances at the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC), Ile-Ife, between 2021 and 2023, in order to examine relationship between these complications and treatment length.

Methods: This was a retrospective analysis that involved the review of clinical records of patients who received orthodontic care within the study period. Information on complication categories, duration of treatment, and appliance type was extracted. Statistical analyses were conducted using SPSS (version 25), and associations between variables were tested with the Chi-square method. Approval for the study was granted by the Institutional Ethics Committee (IPH/OAU/12/2034).

Results: Out of 90 eligible patient records, the most common adverse event was gingival hyperplasia (63.1%), followed by gingival pain and swelling (17.9%), mucosal ulceration (9.5%), and other less frequent periodontal issues (9.5%). A statistically significant difference was observed between complication type and treatment stage ($\chi^2 = 19.13$, $df = 7$, $p = 0.008$). A statistically significant difference was also seen between complication type and treatment duration ($\chi^2 = 52.41$, $df = 21$, $p < 0.001$).

Conclusion: Orthodontic complications varied between stages of treatment and duration. Gingival hyperplasia emerged as the predominant complication, particularly in prolonged treatment cases. Routine periodontal assessment and timely intervention may reduce the incidence and severity of such outcomes.

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Introduction

Orthodontics, derived from the Greek words *ortho* (which means straight or correct) and *odont* (which means tooth), is a specialized branch of dentistry that addresses the diagnosis, prevention, interception, correction of orofacial irregularities and malocclusion¹

Malocclusion has negative effects on craniofacial development, oral health and function, and patients' psychological and social life. If left untreated it increased the risk of individual to be prone to oral complications like periodontal disease, caries and gingival inflammation, as well as systemic diseases resulting from impaired mastication and altered nutrition.^{2,3}

Orthodontic treatment plays a crucial role in correcting malocclusion and enhancing dental function and facial appearance. Despite improvements in treatment techniques and appliance designs, orthodontic care still presents with challenges. Patients may experience complications at various stages of treatment, ranging from mild discomfort to more serious dental or periodontal problems such as caries, mucosal injuries, gingival inflammation, and other tissue damages that may affect patient comfort, treatment progress, and outcomes.^{4,5} Patient's oral hygiene, type of orthodontic appliance, period of treatment, and individual susceptibility are important factors influencing the occurrence of these complications⁵.

The different types of appliances used for orthodontic treatments are associated with different types of oral health problem. The fixed orthodontics appliances, are linked with plaque retention and gingival changes, while removable appliances may cause injuries to the soft tissue.⁶ Identifying the types and frequency of such complications is important, as it allows clinicians to expect possible side effect, tailor possible preventive strategies, and provide appropriate patients awareness, this in turn enables orthodontics to counsel patients on prevention and improve treatment.

This aim of this study was to identify and compare the types and frequency of complications experienced by patients associated with the use of fixed and removable appliances during orthodontic treatment over a period of three years (2021–2023) at the Orthodontic Unit of the Obafemi Awolowo University Teaching Hospital Complex (OAUTHC), Ile-Ife.

Materials And Methods

This study employed a retrospective cross-sectional design employing the use of existing patient records from the Orthodontic Unit of the Obafemi Awolowo University Teaching Hospitals Complex (OAUTHC) in Ile-Ife, Nigeria.

All patients that had received or were receiving orthodontic treatment over a three-year period from 2021 to 2023, with either fixed or removable appliances were included in the study. Patients who had orthognathic surgery and patients with incomplete documentation or who stopped treatment before the first review visit were excluded.

Sociodemographic data recorded, include age categorized into 6–15, 16–25, 26–35, and above 35years, sex (male or female), and occupation (student, unemployed, artisan, civil servant, or self-employed). Clinical and treatment-related variables were also documented, such as the type of orthodontic appliance used (fixed, removable, or sectional fixed), the stage of treatment at the time data collection (ongoing or completed), where ongoing treatment referred to cases with appliances still in place and completed treatment referred to cases in which appliances had been removed before data

extraction, and treatment duration, classified into one-year increments ranging from one to eight years.

Complications associated with treatment were identified from the patient records and recorded as present or absent. Complications were recorded only when clearly documented in the patients' clinical records by attending orthodontist.

- Dental caries: Records indicating visible decay on occlusal or aproximal tooth surfaces were classified as dental caries.
- Generalized gingival hyperplasia: Defined as gum enlargement that extended more than one quadrant of the mouth.
- Mucosal ulceration: Described as soreness or breakdown of the oral lining in contact with appliance
- Gingival pain and swelling: Referred to patient reported gingival discomfort accompanied by clinically documented gingival swelling in the absence of abscess formation.
- Periodontal pocket with gingival swelling: Defined as a periodontal pocket recorded in association with gingival swelling at the same site.
- Gingival abscess: Identified from description of painful, localized swellings with pus discharge
- Chronic generalized gingivitis: Defined as generalized gingival inflammation affecting the multiple sites, characterized by erythema, swelling, or bleeding

Entries reporting localized gum pain with observable swelling were recorded accordingly as stated in the patients clinical records.

For certain analyses, complications were grouped into four categories: generalized gingival hyperplasia; mucosal ulceration; gingival pain and swelling; and other complications, which encompassed dental caries, periodontal pocket with swelling, gingival abscess with swelling, and chronic generalized gingivitis. Only patient with complete documentation of complications and treatment stage were included in the analysis.

Data Analysis

Data analysis was performed using statistical software, Statistical Package for the Social Sciences (SPSS) version 25. Descriptive statistics were

calculated to summarize all categorical variables, with frequencies and percentages. Inferential analysis was conducted using the Chi-square Test of Independence. Two primary associations were tested: between the original eight complication types and the stage of treatment, and between the four complication categories and treatment duration. Statistical significance was set at $p \leq 0.05$

Ethical consideration

Ethical approval for the study was obtained from the OAUTHC Institutional Review Board. (IPH/OAU/12/2034). The study was conducted using anonymized patient records. A waiver was obtained for participants' informed consent.

Results

A total of 90 patient records were reviewed for this study. Most of the patients fell into the 16–25-year age group (44.4%), with a smaller number in the 25–26 years range (25.6%) and the 7–15 years range. Only (9.3%) of the patients were between 36 and 50 years old. There were more female patients than the males. The patients were predominantly Students (64.4%), while civil servants accounted for about one-fifth. Others were self-employed (8.9%), artisans (3.3%), and unemployed (2.2%). Fixed appliances therapy was the most common treatment type (94.4%), with only 2.2% patients treated with removable or sectional fixed appliances (1.1%). At the time of review, most cases (70.6%) were still ongoing treatment (Table 1)

Table 1: Sociodemographic and types of orthodontic treatment

Age Category	Frequency (n=90)	Percentage (%)
7-15	19	21.1
16-25	40	44.4
26-35	23	25.6
36-50	8	9.3
SEX		
Male	30	33.3
Female	60	66.7
OCCUPATION		
Student	58	64.4
Unemployed	2	2.2
Artisan	3	3.3
Civil servant	19	21.1
Self employed	8	8.9
TYPE OF APPLIANCE		
Fixed appliance	87	94.4
Removable appliance	2	2.2
Sectional fixed appliance	1	1.1
STAGES OF TREATMENT		
ONGOING	64	70.6
COMPLETED	26	29.5

A higher percentage of the patients (58.9%) did not have complications. Among those who had complications, the most frequent was gingival pain and swelling (16.7%), followed by gingival hyperplasia (8.9%) and periodontal pockets with

swelling (6.7%), mucosal ulceration (3.3%) and Occlusal caries (2.2%) chronic generalized gingivitis (2.2%) and gingival abscess with pain (1.1%) were less common (Table 2)

Table 2: Treatment complications of participants

Treatment Complication Frequency	Frequency (n)	Percentage (%)
Dental caries	2	2.2
Generalized gingival hyperplasia	8	8.9
Mucosal ulceration	3	3.3
Periodontal pocket and gingival swelling	6	6.7
Gingival pain and swelling	15	16.7
Gingival abscess and pain	1	1.1
Chronic generalized gingivitis	2	2.2
No complication	53	58.9

Chi-square analysis showed a statistically significant association between the type of complication and the treatment stage ($\chi^2 = 19.13$, $df = 7$, $p = 0.008$). Most patients without complications were still undergoing

treatment, whereas certain complications, such as gingival pain and swelling, appeared more frequently in completed cases. (Table 3)

Table 3: Cross tabulation of complications vs stage of treatment

Treatment Complication	Ongoing n (%)	Completed n (%)	Total n (%)
Occlusion caries	1 (50.0)	1 (50.0)	2 (100.0)
Generalized gingival hyperplasia	6 (75.0)	2 (25.0)	8 (100.0)
Mucosal ulceration	2 (66.7)	1 (33.3)	3 (100.0)
Periodontal pocket and gingival swelling	3 (50.0)	3 (50.0)	6 (100.0)
Gingival pain and swelling	6 (40.0)	9 (60.0)	15 (100.0)
Gingival abscess and pain	1 (100.0)	0 (0.0)	1 (100.0)
Chronic generalized gingivitis	0 (0.0)	2 (100.0)	2 (100.0)
No complication	45 (84.9)	8 (15.1)	53 (100.0)
Total	64 (71.1)	26 (28.9)	90 (100.0)

Chi-square test: $\chi^2 = 19.129$, $df = 7$, $p = 0.008$.

Note: 75% of the cells had an expected count below 5.

Complications were classified as generalized gingival hyperplasia (Category 1), Category 2 – mucosal ulceration, Category 3 – gingival pain and

swelling, and Category 4 – other complications (Dental caries, periodontal pocket with swelling, gingival abscess with swelling, chronic generalized

gingivitis). Types of complications differed significantly across treatment durations ($\chi^2 = 52.41$, $df = 21$, $P = 0.001$). The most frequent category was category 1 (63.1%), which occurred mainly in the patients treated for 2 to 4 years. While Category 2

(9.5%) occurred predominantly within the first year (50%), Category 3 (17.9%) peaked at three years (40%), and Category 4 (9.5%) was concentrated in patients treated for three years (50%) and eight years (25%) (Table 4)

Table 4: Complication versus Treatment duration (N=84)

Complication category	1yr	2yrs	3yrs	4yrs	5yrs	6yrs	7yrs	8yrs	Total (%)
Gingival hyperplasia	1(1.9)	20(37.7)	12(22.6)	12(22.6)	3(5.7)	1(1.9)	2(3.8)	2(3.8)	53(63.1)
Mucosal ulceration	4(50.0)	1(12.5)	2(25.0)	0(0.0)	0(0.0)	1(12.5)	0(0.0)	0(0.0)	8(9.5)
Gingival pain/swelling	2(13.3)	1(6.7)	6(40.0)	1(6.7)	2(13.3)	3(20.0)	0(0.0)	0(0.0)	15(17.9)
Other complications	0(0.0)	1(12.5)	4(50.0)	0(0.0)	1(12.5)	0(0.0)	0(0.0)	2(25.0)	8(9.5)
Total	7(8.3)	23(27.4)	24(28.6)	13(15.5)	6(7.1)	5(6.0)	2(2.4)	4(4.8)	84(100)

Discussion

This retrospective review of 90 orthodontic patient records from the Orthodontic Unit of the Obafemi Awolowo University Teaching Hospitals Complex, Ile-Ife, covered three years (2021–2023) and aimed to identify complications associated with the use of fixed and removable appliances during treatment and immediately after completion. Most patients were young adults aged 16–25 years, with female students making up the largest group. Fixed appliances were used in almost all cases, and just over two-thirds of treatments were still ongoing at the time of review. Slightly more than half of the patients had no recorded complications. Among those who experienced adverse events, the most common were gingival pain and swelling, followed by generalized gingival hyperplasia. When grouped into categories, gingival hyperplasia accounted for nearly two-thirds of all complications. Statistical analysis showed significant associations between the type of complication and both the stage of treatment and the duration of appliance use.

This study offers several notable strengths. It represents the first documentation of orthodontic complication patterns in a Nigerian tertiary hospital, filling an important gap in the regional literature. The methodology was standardized, with clearly defined

inclusion and exclusion criteria and systematic data extraction from clinical records. The analysis was comprehensive, combining descriptive summaries with inferential statistics to explore associations between variables. Ethical standards were upheld through institutional approval and the use of anonymised patient data, ensuring confidentiality and compliance with research governance requirements.

The analysis revealed distinct patterns according to treatment stage and duration. During active treatment, gingival hyperplasia, gingival pain and swelling, and periodontal pockets were the most prevalent findings, whereas post-treatment records showed persistent gingival pain and swelling in a substantial proportion of patients. Complication patterns were also time-dependent: mucosal ulceration peaked in the first year, likely reflecting the adaptation phase; gingival pain and swelling were most frequent in the third year, suggesting cumulative inflammatory changes; and gingival hyperplasia was most common between the second and fourth years, consistent with prolonged plaque retention and chronic irritation²². Statistical testing confirmed significant associations between complication type and both treatment stage.

These findings align closely with prior evidence from Nigerian⁷ and international literature^{6,8} showing that

fixed appliances predispose to inflammatory complications due to plaque accumulation around brackets and wires. This heightened susceptibility necessitates rigorous oral hygiene practices and regular professional intervention to mitigate these adverse effects throughout the treatment duration.⁹

The demographic profile of the cohort predominantly young adults, most of whom were students mirrors that reported in other Nigerian orthodontic studies^{10,11} and may explain challenges with oral hygiene compliance^{7,11} which can heighten the risk of inflammatory complications.¹² Age-related behavioral factors, such as dietary choices and inconsistent brushing routines, appear to play a significant role in the onset and severity of plaque-induced conditions during orthodontic treatment.^{13,14} In addition, the age can be associated with varying levels of oral hygiene awareness and compliance.¹⁵ These issues underscore the critical importance of investigating the specific patterns of inflammatory complications and oral hygiene challenges within diverse orthodontic patient populations.¹⁶ This study's analysis of the prevalence and contributing factors of inflammatory complications among orthodontic patients in a Nigerian tertiary healthcare setting provides insights into localized oral health challenges.¹⁷ Such regional data are crucial for developing targeted preventive strategies and tailored patient education programs to improve orthodontic outcomes and minimize iatrogenic effects.¹⁸ In addition, this paper contributes to the broader understanding of orthodontic sequelae by highlighting the specific complications encountered within this demographic, including issues related to gingival recession¹⁹ and the efficacy of various preventive measures²⁰

The study observed that mucosal ulceration occurred among patients using removable appliances, although this appliances were used in only a small fraction of cases, this observation is consistent with earlier reports attributing mucosal ulceration during removable orthodontic therapy to trauma from appliance components, especially from clasps during the initial adjustment period,^{21,23}. The infrequent use

of removable appliances in the present study limited the depth of analysis possible for their associated complications. Further research exploring the specific design characteristics of removable appliances and the length of their adaptation period would help clarify the mechanisms that contribute to mucosal trauma.

The timing of these complications provides further clinical insight. Early treatment stages were marked by appliance adaptation issues such as ulceration²³ mid-treatment years by sustained inflammatory responses leading to hyperplasia^{6,24} and pain²⁵ and extended treatments by increased risk of caries and periodontal pockets^{26,27}. The persistence of gingival pain and swelling after treatment completion suggests delayed resolution of inflammation²⁵ and underscores the need for post debonding monitoring.

These results carry practical implications. Preventive measures should be tailored to treatment phases: early in treatment, strategies such as protective wax and targeted hygiene instruction may reduce ulceration²⁸ in the mid-treatment years, intensified prophylaxis, including antimicrobial rinses, can help counteract hyperplasia and discomfort⁶ and in longer treatments, periodontal surveillance and caries-preventive measures such as fluoride varnish²⁶ are warranted. Following appliance removal, scheduled follow-up visits can address residual inflammation²⁵ and promote tissue healing.

In conclusion, fixed appliances at OAUTHC were strongly associated with time-dependent gingival inflammation, which often peaked mid-treatment and sometimes persisted beyond therapy. Mucosal ulceration was more characteristic of early removable appliance use, though its low occurrence limited detailed evaluation. The adoption of stage-specific preventive protocols focused on hygiene reinforcement and inflammation control could improve treatment outcomes. Future prospective studies that track oral hygiene status and patient compliance will be essential to confirm causal pathways and refine prevention strategies.

Limitation

This study is limited by its retrospective design, which relied on existing patient records and may have missed undocumented complications. Many of the complication categories had small counts, which limits the strength of the statistical power. Being a single-center study may limit generalizability, and important confounders, including oral hygiene, socioeconomic status, and patient compliance, were not measured. Furthermore, the operational definition of dental caries in this study was restricted to occlusal and interproximal lesions, excluding enamel decalcification and labial surface caries. This restriction may have led to an underestimation of the true burden of caries-related complications and

represents a source of classification bias. Finally, the lack of post-treatment follow-up may have underestimated late-onset complications. These limitations should be considered when interpreting the findings.

Conflict of interest

The authors declare that they have no conflict of interest

Funding

No funding was received for this study

Authors' contributions

FAD conceptualized the study. SNM collected all the data. FAD did the data analysis. FAD and SNM wrote the initial draft of the manuscript. All authors reviewed the final draft of the manuscripts.

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