

Radiographic Assessment of Postorthodontic Complications in a Nigerian Population

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Abstract

Background: Orthodontic treatment though highly beneficial has some potential risks. **Aim:** This study aimed to determine the prevalence of radiographic complications seen on the teeth and tooth-supporting structures following orthodontic treatment and to determine their relationship with certain patient-related factors. **Materials and Methods:** This study was carried out among patients who have undergone fixed orthodontic therapy. The clinical records, pretreatment orthopantomogram (OPG), and posttreatment OPG for each case were retrieved, and relevant information was extracted (age, gender, motivation for treatment, duration of treatment, number of missed appointments, and intervals between missed appointments). The pre- and post-treatment OPGs were examined under adequate illumination and compared for changes such as root resorption, dental caries, and interdental bone loss. Data collected were analysed using IBM SPSS version 23. $P \leq 0.05$ was considered statistically significant. **Results:** The study participants consisted of 10 (45.5%) males and 12 (54.5%) females, with a mean age of 12.0 ± 2.2 years. The motivation for treatment was mostly primary (68.2%) and the mean duration of treatment was 41 months. All participants had missed appointments during their treatment, with a mean of 5.67 missed appointments and a mean interval between missed appointments of 4.69 weeks. Root resorption was present in 9 (40.9%) participants and alveolar bone loss in 6 (27.3%) participants, whereas no case of dental caries was seen following orthodontic treatment. Factors associated with root resorption were female gender, secondary motivation for orthodontic treatment, mean duration of treatment ≥ 38 months, number of missed appointments ≥ 6 , and mean interval between missed appointments of ≥ 6 weeks. Factors associated with alveolar bone loss were male gender, mean duration of treatment ≥ 45 months, number of missed appointments ≥ 8 , and mean interval between missed appointments of ≥ 6 weeks. **Conclusion:** Complications involving the teeth and tooth-supporting structures following fixed orthodontic treatment may be common, but the extent and severity are often limited.

Keywords: Bone loss, complications, Nigeria, orthodontic treatment, root resorption

INTRODUCTION

Orthodontic treatment involves the application of forces on the teeth and jaws to correct malocclusion through the movement of teeth and/or remodelling of the jaw bones. Before the commencement of orthodontic treatment, thorough patient evaluation is essential to ensure that the potential benefits outweigh the possible risks.^[1] The potential benefits include improved aesthetics, improvement in mastication, improvement/correction of speech problems, reduced susceptibility to dental caries and periodontal diseases, prevention of dentoalveolar trauma, and prevention and treatment of temporomandibular disorders.^[1-3] In addition, orthodontic treatment has also been reported to improve social and psychological well-being as well as quality of life.^[1] However, orthodontic treatment is not without potential risks/complications. Such complications

include dental complications (pain, enamel decalcification, and dental caries), periodontal complications (gingivitis, periodontitis, gingival recession, root resorption, and alveolar bone loss), and temporomandibular disorders (condylar resorption and temporomandibular dysfunction).^[4,5] Factors that influence the occurrence of these complications include patient factors (age, genetic predisposition, type and severity of malocclusion, compliance with appointments, and oral

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hygiene), doctor-related factors (knowledge and skill), and appliance-related factors (type of appliance, amount of force, and type of material).^[6] While some complications of orthodontic treatment such as pain, gingivitis, enamel decalcification, and dental caries can be assessed clinically, others such as alveolar bone loss, root resorption, and condylar resorption require some form of imaging for accurate assessment.

Imaging modalities that have been used for the radiologic assessment of the teeth and mandibular condyles/temporomandibular joint (TMJ) in orthodontic practice include cephalometric radiography, orthopantomography, computed tomography (CT), magnetic resonance imaging (MRI), and cone-beam CT (CBCT).^[7] MRI is relatively safe, as it does not involve radiation. However, it is most useful for the soft-tissue components of the TMJ, as it gives a poorer representation of the bony components.^[7-9] CT gives a good representation of hard tissues but exposes patients to large doses of radiation. Thus, it is preferred for imaging large areas of the body.^[8,9] CBCT is desirable because it gives a good representation of bony tissues and exposes patients to much lower doses of radiation compared to conventional CT.^[8,9] However, the equipment is expensive and not readily available in most parts of Nigeria. In addition, the dose of radiation an individual is exposed to during a CBCT is about 3–6 times more than that of an orthopantomogram (OPG) and about 15–26 times more than that of a lateral cephalogram.^[10] Hence, CBCT is not recommended for use in all orthodontic patients.^[10] A conventional lateral cephalogram is routinely used in orthodontics for diagnosis and treatment planning, but it is not suitable for the assessment of the teeth and alveolar bone due to superimposition of the contralateral structures.^[11] Our choice of using OPG was based on its adequate visualisation of the teeth/TMJ, availability, affordability, and relative ease of use.^[12,13]

Despite the growing number of orthodontists and patients seeking orthodontic treatment in Nigeria, only few studies have examined the complications that may arise from orthodontic treatment. More so, most of these have been based on the clinical assessment, especially the oral hygiene status.^[14-17] The aim of this study was (i) to determine the prevalence of radiographic complications (root resorption and alveolar bone loss) seen on the teeth and tooth-supporting structures following orthodontic treatment and (ii) to determine the relationship between radiographic complications (root resorption and alveolar bone loss) following orthodontic treatment and certain patient-related factors (age, gender, motivation for treatment, duration of treatment, number of missed appointments during treatment duration, and the interval between missed appointments).

MATERIALS AND METHODS

This was a retrospective study carried out among patients who have undergone fixed orthodontic therapy at the orthodontic

unit of the Department of Child Dental Health, University of Port Harcourt Teaching Hospital (UPTH), Port Harcourt, Nigeria. To limit the influence of doctor-related factors, only patients treated by a single orthodontist were included in this study. Other inclusion criteria were (i) those who had completed their orthodontic treatment as of December 31, 2022, (ii) those who had pretreatment and posttreatment OPGs available, (iii) those with adequate clinical records, and (iv) those treated with conventional preadjusted edge-wise bracket system. Ethical clearance was obtained from the ethics review committee of the University of Port Harcourt Teaching Hospital (Protocol number: UPTH/ADM/90/S.R/VOL.XI/1185). The clinical records and pretreatment and posttreatment OPGs of each eligible patient were retrieved, and relevant information was extracted. Information extracted from the clinical records was age (at the commencement of orthodontic treatment), gender, who demanded treatment (patient = primary and parents/others = secondary), duration of treatment, number of missed appointments, and intervals between missed appointments.

All the radiographs were taken using Planmeca Promax panoramic device, and the assessment of the radiographs was done by the same author. The pre- and post-treatment OPGs were thoroughly examined under adequate illumination and the pre- and post-treatment OPGs were compared. The following parameters were then recorded: presence and extent of root resorption, number of teeth affected by root resorption, presence/absence of dental caries, presence of interdental bone loss, and the number of teeth affected. The severity of root resorption was graded as follows: ^[13,18] mild = ≤ 2 mm, moderate = resorption from 2 mm up to one-third of the root length, and severe = $>$ one-third of the root length.

The data collected were entered into a spreadsheet and analysed using IBM SPSS for Windows version 23, Chicago, IL, USA. Descriptive statistics was performed, and results were presented as frequencies and percentages. Test for normality of the data was done using the Shapiro–Wilk test. The relationship between root resorption/alveolar bone loss and qualitative variables (gender and motivation for treatment) was assessed using the Chi-square test of association, whereas the relationship between root resorption/alveolar bone loss and quantitative variables (mean age, mean duration of treatment, mean number of missed appointments, and mean interval between missed appointments) was determined using an independent sample's *t*-test. $P \leq 0.05$ was considered statistically significant in all cases.

RESULTS

Epidemiology

There were 22 participants who met the inclusion criteria for this study, consisting of 10 (45.5%) males and 12 (54.5%) females. The age of the study participants ranged from 8 to 17 years, with a mean of 12.0 ± 2.2 years. The Shapiro–Wilk test for normality showed that the data were normally distributed.

Orthodontic treatment parameters

The majority (68.2%) of the participants sought treatment primarily because they did not like their appearance (primary motivation), whereas the remaining sought treatment because their parents wanted them to undergo treatment (secondary motivation). The duration of orthodontic treatment in this study was between 8 and 79 months, with a mean duration of 41 ± 17.2 months. Over the course of their treatment, all the study participants missed between 2 and 14 of their follow-up appointments, with a mean of 5.67 ± 2.97 missed appointments. The interval between missed appointments varied between 1.5 and 10.6 weeks, with a mean of 4.69 ± 2.21 weeks.

Orthodontic treatment complications

Overall, radiographic complications of orthodontic treatment were seen in 54.5% of participants. Root resorption was present in 9 (40.9%) participants, whereas alveolar bone loss was seen in six (27.3%) participants. There was no recorded case of dental caries following orthodontic treatment. In all cases, root resorption was mild, with the average amount of root resorption being 1.5 mm. The number of teeth affected ranged between 1 and 8.

Determinants of orthodontic treatment complications

The mean age of those who had root resorption was 11.7 years, and root resorption was more common in females (55.6%) and in those whose motivation for orthodontic treatment was secondary (55.6%). Other orthodontic treatment parameters associated with root resorption were mean duration of treatment ≥ 38 months, number of missed appointments ≥ 6 , and mean interval between missed appointments of ≥ 6 weeks. There was no significant association between root resorption and age ($P = 0.626$), gender ($P = 0.937$), duration of treatment ($P = 0.555$), and number of missed appointments ($P = 0.445$). However, there was a significant association between the occurrence of root resorption and motivation for treatment ($P = 0.047$) as well as the average duration between missed appointments ($P = 0.040$).

Alveolar bone loss occurred in 6 (27.3%) participants, with a mean age of 12.5 ± 1.4 years, and males were more often affected (66.7%). Other orthodontic treatment parameters associated with alveolar bone loss were mean duration of treatment ≥ 45 months, number of missed appointments ≥ 8 , and mean interval between missed appointments of ≥ 6 weeks. However, only the relationship between alveolar bone loss and mean number of missed appointments was statistically significant ($P = 0.041$) [Table 1].

DISCUSSION

Orthodontic treatment though beneficial in improving aesthetics, mastication, and speech problems, while also helping to prevent dentoalveolar trauma, is not without some potential complications.^[1,4] While some of these complications can be assessed clinically, others require radiographic imaging for proper assessment. The current study sought to determine

the radiographic complications following orthodontic treatment in a Nigerian population while also assessing certain patient-related factors and the occurrence of these complications. This study had a relatively small sample of 22 participants, due to a number of reasons: (i) the number of individuals seeking orthodontic treatment in this part of the world constitutes only a small fraction of those needing treatment, due to the high cost of treatment, especially because dental treatment is predominantly out-of-pocket.^[19,20] More so, the reason most people seek dental care is because of pain,^[21] which is not commonly associated with malocclusion, (ii) only participants treated by one orthodontist were included, to eliminate the influence of doctor-related factors, and (iii) limited availability of adequate pre- and post-treatment radiographs and clinical records.

All the study participants were between 8 and 17 years of age. This is in keeping with previous studies, which have reported that most patients seeking orthodontic treatment were between 11 and 20 years of age.^[14,16,22,23] This is a period of active skeletal growth, and orthodontist utilises this knowledge to achieve maximal benefits from treatment.^[24] There were more females than males in this study, similar to what has been reported in previous hospital-based Nigerian studies.^[14,16,22,23,25] This has been attributed to better health-seeking behaviour among females, especially in a field-like orthodontics where improvement in aesthetics is a major reason for seeking care.^[25,26]

Although the major motivation for seeking orthodontic treatment is improvement in aesthetics, several other factors have also been mentioned, including better quality of life, ease of getting a job, ease of getting into a romantic relationship, and improved self-esteem.^[27] The majority (68.2%) of the participants in the current study sought treatment primarily because they did not like their appearance (primary motivation), whereas others sought treatment because of their parents (secondary motivation). Due to their eagerness to improve their appearance, those with primary motivation may adhere better to treatment guidelines and follow-up appointments. This study found a lower incidence of root resorption among those who were primarily motivated.

Root resorption of the tooth apex during orthodontic treatment though undesirable is often unavoidable. Some degrees of external root resorption are inevitable with fixed appliance treatment, although the extent is unpredictable.^[3] Clinical evidence of this resorption is not seen in many instances, but radiographs may reveal some degrees of apical resorption.^[4] In the current study, root resorption was seen in 40.9% of participants, and in all cases, it was mild. In a study by Maués *et al.*,^[28] 31.6% of cases showed no root resorption, 22.5% showed irregular root contour, whereas 45.8% of cases showed active root resorption, similar to the findings of this study. Other studies have reported the occurrence of root resorption among orthodontic patients to be 27.7%^[13] and 56%.^[12] These differences may be due to various patient and doctor-related

Table 1: Comparison of patient-related factors among those with and without orthodontic treatment complications

Patient-related factor	Root resorption		P
	Absent, n (%)	Present, n (%)	
Mean age (years)	12.2±2.5	11.7±2.0	0.626
Gender			
Male	6 (60)	4 (40)	0.937
Female	7 (58.3)	5 (41.7)	
Motivation			
Primary	11 (73.3)	4 (26.7)	0.047*
Secondary	2 (28.6)	5 (71.4)	
Mean duration of treatment (months)	42.9±22.5	38.4±10.7	0.555
Mean number of missed appointments	5.2	6.2	0.445
Mean interval between missed appointments (weeks)	3.8±1.2	6.0±2.7	0.040*
Patient-related factor	Alveolar bone loss		P
	Absent, n (%)	Present, n (%)	
Mean age (years)	11.73±2.5	12.5±1.4	0.494
Gender			
Male	6 (60)	4 (40)	0.221
Female	10 (83.3)	2 (16.7)	
Motivation			
Primary	10 (66.7)	5 (33.3)	0.350
Secondary	6 (85.7)	1 (14.3)	
Mean duration of treatment (months)	39.3±20.7	45.2±9.8	0.520
Mean number of missed appointments	4.9±2.2	7.7±3.8	0.041*
Mean interval between missed appointments (weeks)	4.3±1.8	5.8±3.0	0.154

*Statistically significant

factors, as well as the type of radiographs used and the method of assessment. Severe root resorption is fortunately rare, occurring in <5% of cases,^[13,29] and the current study recorded no case of severe root resorption. The 14.8%^[13] and 32%^[12] recorded by two previous studies were due to the fact that they categorised both degree 2 (moderate) and degree 3 (severe) as severe root resorption, hence the overestimation.

Factors that have been associated with root resorption in the literature include age, gender, type of malocclusion, type of orthodontic appliance, type of orthodontic tooth movement, duration of treatment, amount of force, whether or not the treatment involved tooth extraction, bone density, root morphology, genetics, habits (nail biting, tongue thrusting, and bruxism), and prior endodontic treatment.^[12,13,28,29] The current study recorded significant associations between the occurrence of root resorption and motivation for orthodontic treatment as well as the mean interval between missed appointments. There was a higher prevalence of root resorption when the parents of a child/adolescent were the ones who wanted treatment rather than the child himself. Such patients may be less likely to see the need for adherence to appointment schedules, optimal maintenance of oral hygiene, and other requirements for a hitch-free orthodontic treatment. All participants in this study had a number of missed appointments, but this is understandable considering the long duration of orthodontic treatment. Intervals between missed appointments ≥ 6 weeks significantly increased the likelihood of root resorption.

The prevalence of alveolar bone loss among orthodontically treated patients in this study was 27.3%. Similarly, Lupi *et al.*^[30] reported increased levels of alveolar bone loss in both anterior and posterior teeth following orthodontic treatment. This may be due to ongoing bone remodelling brought about by orthodontic tooth movement and difficulty in maintaining good oral hygiene during the treatment period. However, other authors have suggested that orthodontic treatment has no negative long-term effect on alveolar bone levels.^[31] This study showed that interdental bone loss was significantly associated with ≥ 8 missed appointments during orthodontic treatment. Follow-up appointments provide a chance for re-enforcement of oral hygiene instructions as well as carrying out routine prophylactic measures. Thus, missed follow-up appointments can potentially increase the accumulation of plaque biofilm in the interdental areas, with subsequent deleterious effects on the alveolar bone.

None of the study participants developed dental caries as a result of orthodontic treatment. Similarly, other authors have found no statistically significant association between orthodontic treatment and decayed teeth or decayed, missing, and filled teeth.^[32,33]

CONCLUSION

Complications involving the teeth and tooth-supporting structures may occur following fixed orthodontic treatment; however, the extent is often minimal as radiologically

confirmed. Some parameters such as missed appointments, patient motivation, and gender had associations with different forms of complications found among patients treated with fixed orthodontic therapy. The findings of the study will help improve preventive measures that will maximise the benefits of orthodontic treatment while limiting complications to the barest minimum.

Recommendation

More time should be spent on patient education regarding compliance with the timing of appointment before the commencement of fixed orthodontic treatment. Further studies will be necessary in the future to know if there will be any reduction in the missed appointment of patients undergoing fixed orthodontic therapy in the same hospital.

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Conflicts of interest

There are no conflicts of interest.

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