



Influence of Asthma on the Degree of Apical Root Resorption in Orthodontically Treated Patients

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Abstract

Background: The purpose of the present study was to evaluate the influence of asthma on the degree of apical root resorption in patients treated orthodontically.

Methods: Sample comprised 683 patients treated orthodontically; 240 with asthma and 443 who did not present any kind of respiratory allergy or asthma. The Levander and Malmgren score was used for the evaluation of the degree of root resorption. This evaluation was performed in the initial and final periapical radiographs of the maxillary and mandibular incisors of all patients in the sample. Then, the sample was divided as follows: Group 1: 614 patients presenting mild or no root resorption with scores 0, 1 and 2, with mean initial age of 14.37 years, final age of 16.44 years and treatment time of 2.07 years; group 2: 69 patients who had moderate to severe root resorption with scores 3 and 4, with mean initial age of 15.09 years, final age of 17.81 years and treatment time of 2.72 years.

Results: The results revealed that asthma was not a statistically significant factor for severe root resorption. The group with severe root resorption showed higher initial and final age, and longer treatment time than the group with mild root resorption. In addition, performing extractions is a risk factor for the occurrence of severe root resorption.

Conclusions: Asthma is not a risk factor for the occurrence of severe root resorption after orthodontic treatment.

Keywords: Orthodontic Treatment, Corrective, Asthma, Root Resorption

1. Background

The apical root resorption is a condition commonly observed during and after orthodontic treatment, leading to a rounding of the radicular apex. This situation results from a complex combination of biological activities, inherent in every patient (1).

This may compromise the affected tooth, because it changes its structure, volume, and root contour due to its delicacy in the apical region (2). However, noting that the process of root resorption caused by orthodontic treatment is typically mild and ceases at the moment the force is removed, many authors agree that the aesthetic and functional benefits justify the risks (3, 4).

Nevertheless, the development of excessive root resorption during orthodontic treatment is considered an undesirable effect of force during tooth movement. Inflammation is an integral part of the tissue response to orthodontic force; in this process, immune cells migrate into

the periodontal ligament and interact with cells residing locally, supporting the idea of a possible association between the orthodontic root resorption and the pathological conditions that affect or involve the immune system (5).

There is hypothesis that subjects who have medical conditions that affect the immune system may be at a high level of risk for the excessive development of root resorption during orthodontic treatment. The incidence of asthma and allergy was significantly greater in patients who have suffered excessive root resorption during orthodontic movement, in comparison to the group of patients who had completed their orthodontic treatment without any systemic problem (6, 7).

Other groups of researchers report that there was no evidence of any relationship between the group of asthmatic patients treated orthodontically and healthy individuals, where both presented similar rates of moderate to

severe root resorption (8, 9).

The scientific literature on this subject is quite restricted, and even diverges in relation to statistical results.

2. Objectives

Thus, the aim of this study was to evaluate the influence of asthma on the degree of apical root resorption in patients treated orthodontically.

3. Methods

3.1. Material

This research was approved by the Ethics Committee of the UNINGA Centro Universitario, Inga. The sample selection was retrospective, performed from the file of the Orthodontics Discipline. It was based exclusively on measuring the degree of initial and final root resorption in the maxillary and mandibular incisors through periapical radiographs before and after orthodontic treatment.

Sample size calculation was performed based on data from a pilot sample. For the purpose of evaluating the degree of apical root resorption, a confidence interval was used for a ratio, considering the confidence interval of 95%, sampling error of 5%, considering a significance level of 5% and power of the test of 80%. Thus, the minimum sample size was 384 roots, that is, 48 individuals, 96 periapical radiographs of 4 incisors, 48 maxillary incisor radiographs and 48 mandibular incisor radiographs (2 periapical radiographs of each individual, where 4 roots will be evaluated in each periapical radiograph, 8 roots of each of the 48 individuals, totaling 384 roots).

The sample comprised 683 patients that had undergone orthodontic treatment which used the same technique with pre-set brackets and it was composed as follows:

240 patients had asthma;

443 patients did not have any kind of allergy or asthma and were considered as the control group.

The variables used for intergroup comparison of the sample, besides the presence or absence of asthma, were gender, type of malocclusion, treatment type, and use of continuous medication. The 683 selected patients were classified as follows:

332 male and 351 female patients;

290 patients presented class I malocclusion, 362 patients presented class II malocclusion and 31 patients presented class III malocclusion;

278 patients were treated with teeth extraction and 405 were treated without extractions;

70 patients were on continuous medication for asthma and 613 patients did not use any kind of continuous medication.

The sample was divided as follows:

Group 1: 614 patients who presented mild resorption with Levander and Malmgren scores of 0, 1 and 2, with mean initial age of 14.37 years, final age of 16.44 years and treatment time of 2.07 years.

Group 2: 69 patients who presented moderate to severe resorption with 04 Levander and Malmgren scores of 3 and 4, with mean initial age of 15.09 years, final age of 17.81 years and treatment time of 2.72 years.

3.2. Methods

The orthodontic folders relating to the sample were used to obtain some relevant data for this study:

The registration data sheet was used to record the patient's full name, gender, date of birth, type of malocclusion, date of beginning and end of treatment;

The patient's anamnesis was used for verification of allergic problems, asthma, bronchitis and deleterious habits;

The initial therapeutic planning of each patient was consulted about the proposed treatment protocol and possible extractions;

The therapeutic procedure was examined with regard to the dates of beginning and end of treatment. These data, together with the patient's date of birth, allowed the exact determination of the total time of treatment and the initial age of the patient.

The Levander and Malmgren score 10 (Figure 1) was used to evaluate the degree of root resorption by observing the initial and final periapical radiographs of each patient in the sample. Each incisor was evaluated in at least two x-rays (initial and final), the signs of root resorption were registered with index values of 0 to 4.

The present score has the following scale:

Grade 0: No root resorption;

Grade 1: Irregular contour of the root;

Grade 2: Apical root resorption less than 2 mm;

Grade 3: Apical root resorption of 2 mm to 1/3 of the original root length;

Grade 4: Apical root resorption exceeding 1/3 of the original root length.

3.3. Statistical Analysis

The intra-examiner error was conducted to verify the reliability of the results obtained, by taking new measurements and calculating a new score for the initial and final periapical radiographs of 100 randomly selected patients, a total of 400 periapical radiographs. The test used was

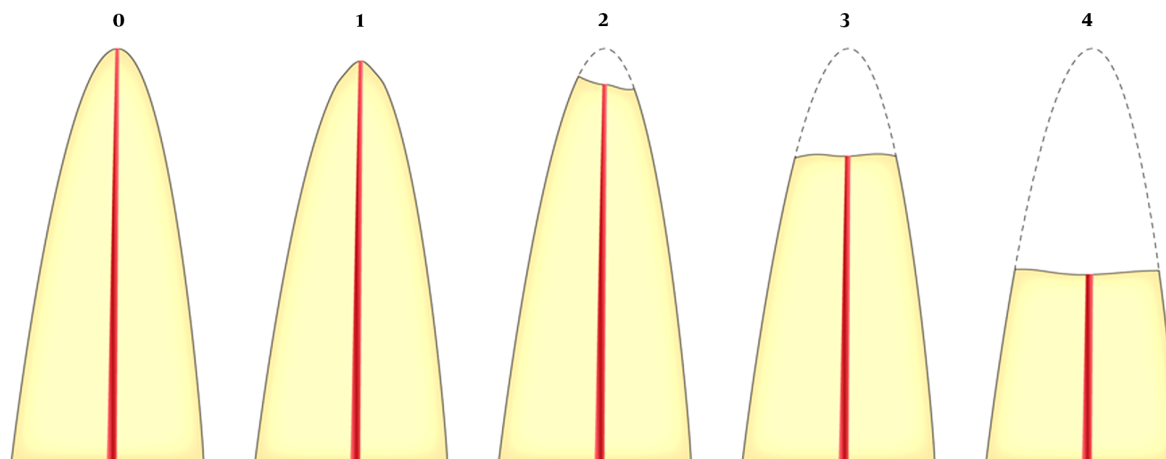


Figure 1. Levander and Malmgren score for evaluation of root resorption.

Kappa which evaluated the agreement in the classification of the degree of external root resorption evaluated by the Levander and Malmgren score (10).

After the measurements of periapical radiographs, and getting the data of each patient, these were statistically analyzed to obtain the results. The independent *t*-test was used to compare the means of the initial and final ages and the treatment time between groups 1 and 2.

After that, the statistical chi-square test was applied to evaluate the existence of the association among the gender variable, type of malocclusion, type of treatment (with or without extraction), presence or absence of asthma and use of continuous medication between groups 1 and 2.

The program used to perform the statistical tests was Statistica (Statistica for Windows, version 7.0, Tulsa, Oklahoma, United States), and the significance level was 5% ($P < 0.05$).

4. Results

Table 1 presents the results of the intra-examiner error, which was conducted by the Kappa test for the assessment of the agreement of the root resorption degree evaluated by the Levander and Malmgren scoring system (10) having as a result the almost perfect agreement force with coefficient value of 0.841, concluding that the measurement error of the root resorption degree of the present study was negligible.

Table 2 shows the results of the independent *t*-test for comparison of the initial and final ages and treatment time between groups 1 and 2.

Table 1. Evaluation of Agreement in Determining the Degree of External Root Resorption Evaluated by the Levander and Malmgren Score (Kappa Test)

	Coefficient Value	Agreement
External root resorption	0.841	Almost perfect

Table 3 shows the chi-square test, with the performances of intergroup evaluation of gender, type of malocclusion (according to Angle classification), type of treatment (with or without extraction), presence or absence of asthma and the use of continuous medication between groups 1 and 2.

5. Discussion

The sample used in this study had a proper number of patients and was homogeneous, since only adolescents aged 11 - 18 years old were treated in this institution. Although the patients were treated by different students, all of them were treated supervised by the same professor.

The form of retrospective assessment of asthma used in this study is valid, since there is scarce research related to this subject in the literature. The ideal would be the clinical evaluation with medical confirmation of the presence of asthma or bronchitis. However, this was not possible since patients had already finished orthodontic treatment.

No comparability of the groups was performed before intergroup comparison, since the main objective was to divide groups regarding amount of root resorption, and then to observe differences in ages, treatment plans, and other characteristics. This way, to perform compatibility of the groups would not make sense.

Table 2. Means and Standard Deviations of Initial and Final Ages and Treatment Time, and the Results of Independent *t*-Tests Between Groups 1 and 2^a

Variables	Group 1 Mild Resorption, N = 614	Group 2 Severe Resorption, N = 69	P Value
Initial age, y	14.37 ± 2.76	15.09 ± 3.44	0.047 ^b
Final age, y	16.44 ± 2.91	17.81 ± 3.66	0.000 ^b
Treatment time, y	2.07 ± 0.93	2.72 ± 1.07	0.000 ^b

^a Values are expressed as mean ± SD.

^b Statistically significant for P < 0.05.

Table 3. Intergroup Comparison of Gender, Malocclusion, Treatment Type, Presence or Absence of Asthma and the Use of Medication Between Groups 1 and 2 (Chi-Square)

Variables	Group 1 Mild Resorption, N = 614	Group 2 Severe Resorption, N = 69	A	GL	P Value
Gender			0.15	1	0.695
Male	300	32			
Female	314	37			
Malocclusion			2.77	2	0.294
CL I	266	24			
CL II	319	43			
CL III	29	2			
Treatment type			1.14	1	0.000 ^a
With Extr	237	41			
Without Extr	377	28			
Asthma			0.04	1	0.841
Yes	215	25			
No	399	44			
Continuous medication use			0.20	1	0.653
Yes	64	6			
No	550	63			

^a Statistically significant for P < 0.05.

There was a statistically significant difference when comparing the mean initial and final ages of the treatment between group 1 (with mild resorption) and group 2 (moderate/severe reabsorption), showing that the group with severe root resorption was older both at the beginning and at the end of orthodontic treatment.

Several authors have reported that age does not influence on root resorption (11-15). However, other authors observed that resorption is more prevalent in adults than in children (16-20).

Adults show greater susceptibility to resorption because when aging the periodontal membrane becomes less vascularized, less elastic, narrower and, the cementum becomes thicker (3, 4). There is also the fact that the apical third of the root is more firmly anchored in adult teeth, which creates a certain difficulty in tooth movement and predisposes to resorption (3, 4). Thus, in adult patients the age may not be the only cause related to root reabsorption

because these teeth may have suffered more traumas than the youngest patient teeth.

When evaluating the influence of treatment time on the apical root resorption in groups 1 and 2, it was found that the group with severe root resorption presented longer treatment when compared to group 1, therefore, it can be inferred that a longer treatment is a risk for the occurrence of severe root resorption.

This result corroborates the findings of several authors who pointed out that the treatment time directly influences the development of root resorption (3, 11, 18, 19, 21-24). It happens because the longer treatment time, the greater will be the teeth movement and possibly greater root resorption will occur.

It was also observed in this study that the association of the variable type of treatment with or without extractions, between groups 1 and 2, showed a statistically significant difference, indicating that performing extractions in

orthodontic treatment is a risk factor for the occurrence of severe root resorption.

Corroborating this result, many studies have shown that patients treated with extractions presented more severe root resorption. This is because the retraction of anterior teeth cause greater movement of the root apex, as well as the need for longer treatment (18, 19, 25).

Asthma has been previously mentioned in the literature as an aggravating factor in the occurrence of root resorption during orthodontic treatment (5, 6, 9), however no study has proved scientifically this relationship.

The present results showed that asthma is not a risk factor for the occurrence of severe root resorption after orthodontic treatment, since the groups with mild/moderate and severe root resorption after orthodontic treatment presented similar distribution of patients with and without asthma (Table 3).

Davidovitch and Krishnan (9) reported a case of a patient with asthma that presented severe root resorption at the end of orthodontic treatment, however the treatment was long, and only one case report does not allow to infer this relation of asthma and the occurrence of severe root resorption. Since root resorption has multifactorial etiology, other factors could influence the occurrence of several root resorption in this clinical case presented.

Our findings confirm the statement that no systemic factor is related to root resorption, (2, 9) since asthma and continuous use of medication to treat this disease were not associated to the occurrence of severe root resorption (Table 3).

However, one should be cautious in the interpretation and extrapolation of the results, since this was a retrospective study and there was no way to evaluate and control the use of medicine and the severity of the allergy and asthma. Perhaps conducting a prospective study including patients with asthma taking medications throughout the orthodontic treatment could produce different results.

5.1. Conclusion

In view of the results obtained in this study, it was found that:

Asthma is not a significant factor for the occurrence of severe root resorption.

An older age, a long treatment time and performing extractions were factors associated to the occurrence of severe root resorption.

Footnotes

Authors' Contribution: Giordana Ariane Ribeiro Schwert Antunes de Melo: Data collection, statistical analyses,

data interpretation and manuscript draft. Karine Martelli: Data checking, manuscript draft and corrections. Karina Maria Salvadore de Freitas: Project idealizer, research supervisor and manuscript draft. Fabrício Pinelli Valarelli: Data checking, manuscript draft and corrections. Rodrigo Hermon Cançado: Data checking, manuscript draft and corrections.

Conflict of Interests: We do not have a significant financial or professional interest in any company, product, or service mentioned in the article.

Ethical Considerations: This research was approved by the Ethics Committee of the UNINGA Centro Universitario, Inga and complies with current ethical considerations.

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References

1. Weltman B, Vig KW, Fields HW, Shanker S, Kaizar EE. Root resorption associated with orthodontic tooth movement: A systematic review. *Am J Orthod Dentofacial Orthop.* 2010;**137**(4):462-76. discussion 12A. doi: [10.1016/j.ajodo.2009.06.021](https://doi.org/10.1016/j.ajodo.2009.06.021). [PubMed: 20362905].
2. Consolaro A. *Dental resorptions in clinical specialties*. 2nd ed. Maringá: Dental Press; 2005.
3. Brezniak N, Wasserstein A. Root resorption after orthodontic treatment: Part 1. Literature review. *Am J Orthod Dentofacial Orthop.* 1993;**103**(1):62-6. doi: [10.1016/0889-5406\(93\)70106-X](https://doi.org/10.1016/0889-5406(93)70106-X). [PubMed: 8422033].
4. Brezniak N, Wasserstein A. Root resorption after orthodontic treatment: Part 2. Literature review. *Am J Orthod Dentofacial Orthop.* 1993;**103**(2):138-46. doi: [10.1016/S0889-5406\(05\)81763-9](https://doi.org/10.1016/S0889-5406(05)81763-9). [PubMed: 8427218].
5. Nishioka M, Ioi H, Nakata S, Nakasima A, Counts A. Root resorption and immune system factors in the Japanese. *Angle Orthod.* 2006;**76**(1):103-8. [PubMed: 16448277].
6. McNab S, Battistutta D, Taverne A, Symons AL. External apical root resorption of posterior teeth in asthmatics after orthodontic treatment. *Am J Orthod Dentofacial Orthop.* 1999;**116**(5):545-51. [PubMed: 10547515].
7. Bartzela T, Turp JC, Motschall E, Maltha JC. Medication effects on the rate of orthodontic tooth movement: A systematic literature review. *Am J Orthod Dentofacial Orthop.* 2009;**135**(1):16-26. doi: [10.1016/j.ajodo.2008.08.016](https://doi.org/10.1016/j.ajodo.2008.08.016). [PubMed: 19121496].
8. Pandis N, Pandis BD, Pandis V, Eliades T. Occupational hazards in orthodontics: A review of risks and associated pathology. *Am J Orthod Dentofacial Orthop.* 2007;**132**(3):280-92. doi: [10.1016/j.ajodo.2006.10.017](https://doi.org/10.1016/j.ajodo.2006.10.017). [PubMed: 17826595].
9. Davidovitch Z, Krishnan V. Role of basic biological sciences in clinical orthodontics: A case series. *Am J Orthod Dentofacial Orthop.* 2009;**135**(2):222-31. doi: [10.1016/j.ajodo.2007.03.028](https://doi.org/10.1016/j.ajodo.2007.03.028). [PubMed: 19201330].
10. Levander E, Malmgren O. Evaluation of the risk of root resorption during orthodontic treatment: A study of upper incisors. *Eur J Orthod.* 1988;**10**(1):30-8. [PubMed: 3162877].
11. Baumrind S, Korn EL, Boyd RL. Apical root resorption in orthodontically treated adults. *Am J Orthod Dentofacial Orthop.* 1996;**110**(3):311-20. [PubMed: 8814033].
12. Harris EF, Baker WC. Loss of root length and creastal bone height before and during treatment in adolescent and adult orthodontic patients. *Am J Orthod Dentofacial Orthop.* 1990;**98**(5):463-9. doi: [10.1016/S0889-5406\(05\)81656-7](https://doi.org/10.1016/S0889-5406(05)81656-7).

13. Harris EF, Kineret SE, Tolley EA. A heritable component for external apical root resorption in patients treated orthodontically. *Am J Orthod Dentofacial Orthop.* 1997;**111**(3):301-9. [PubMed: 9082853].
14. Goldin B. Labial root torque: Effect on the maxilla and incisor root apex. *Am J Orthod Dentofacial Orthop.* 1989;**95**(3):208-19. [PubMed: 2923101].
15. Hendrix I, Carels C, Kuijpers-Jagtman AM, Van T Hof M. A radiographic study of posterior apical root resorption in orthodontic patients. *Am J Orthod Dentofacial Orthop.* 1994;**105**(4):345-9. doi: 10.1016/S0889-5406(94)70128-8. [PubMed: 8154459].
16. Reitan K. Initial tissue behavior during apical root resorption. *Angle Orthod.* 1974;**44**(1):68-82. [PubMed: 4520953].
17. Linge BO, Linge L. Apical root resorption in upper anterior teeth. *Eur J Orthod.* 1983;**5**(3):173-83. [PubMed: 6578039].
18. Sameshima GT, Sinclair PM. Predicting and preventing root resorption: Part II. Treatment factors. *Am J Orthod Dentofacial Orthop.* 2001;**119**(5):511-5. doi: 10.1067/mod.2001.113410. [PubMed: 11343023].
19. Sameshima GT, Sinclair PM. Predicting and preventing root resorption: Part I. Diagnostic factors. *Am J Orthod Dentofacial Orthop.* 2001;**119**(5):505-10. doi: 10.1067/mod.2001.113409. [PubMed: 11343022].
20. Mavragani M, Vergari A, Sellisetth NJ, Boe OE, Wisth PL. A radiographic comparison of apical root resorption after orthodontic treatment with a standard edgewise and a straight-wire edgewise technique. *Eur J Orthod.* 2000;**22**(6):665-74. [PubMed: 1121602].
21. Brin I, Tulloch JF, Koroluk L, Philips C. External apical root resorption in Class II malocclusion: A retrospective review of 1- versus 2-phase treatment. *Am J Orthod Dentofacial Orthop.* 2003;**124**(2):151-6. doi: 10.1016/S0889540603001665. [PubMed: 12923510].
22. McFadden WM, Engstrom C, Engstrom H, Anholm JM. A study of the relationship between incisor intrusion and root shortening. *Am J Orthod Dentofacial Orthop.* 1989;**96**(5):390-6. [PubMed: 2683733].
23. Apajalahti S, Peltola JS. Apical root resorption after orthodontic treatment: A retrospective study. *Eur J Orthod.* 2007;**29**(4):408-12. doi: 10.1093/ejo/cjm016. [PubMed: 17631606].
24. Mirabella AD, Artun J. Risk factors for apical root resorption of maxillary anterior teeth in adult orthodontic patients. *Am J Orthod Dentofacial Orthop.* 1995;**108**(1):48-55. [PubMed: 7598104].
25. Marques LS, Ramos-Jorge ML, Rey AC, Armond MC, Ruellas AC. Severe root resorption in orthodontic patients treated with the edgewise method: Prevalence and predictive factors. *Am J Orthod Dentofacial Orthop.* 2010;**137**(3):384-8. doi: 10.1016/j.ajodo.2008.04.024. [PubMed: 20197177].