

## Original Research

### Assessment of prevalence of apical root resorption during orthodontic treatment

<sup>1</sup>Monika Chib, <sup>2</sup>Mohammad Mushtaq

<sup>1</sup>MDS, <sup>2</sup>Head of the Department, Department of Orthodontics & Dentofacial Orthopedics, Government Dental College & Hospital, Srinagar, Jammu & Kashmir, India

#### ABSTRACT:

**Background:** Apical root resorption (ARR), a permanent loss of hard tissue on the root apex of a tooth, is one of the most undesirable side effects during orthodontic treatment. The present study was conducted to assess prevalence of apical root resorption during orthodontic treatment. **Materials & Methods:** The study sample consisted of 100 orthodontically treated patients (53 females and 47 males; mean age: 14.4±2.8 years). OIIEARR was evaluated using pre- and post-treatment panoramic radiographs for all the tooth groups. Teeth with severe resorption were also assessed. Patient and treatment-related risk factors for OIIEARR were assessed statistically using Pearson's chi-squared test, independent-samples t test, and one-way ANOVA. **Results:** The incidence of severe root resorption following orthodontic treatment was 10.8%. Males exhibited a higher incidence of root resorption compared to females. Orthodontic treatment duration and treatment with extractions were positively correlated with OIIEARR ( $P < 0.05$ ). OIIEARR was observed most frequently in maxillary incisors, followed by mandibular incisors. **Conclusion:** Orthodontic treatment with extraction, prolonged treatment duration, and large movements of the incisors should especially be taken into consideration for OIIEARR risk. Routine radiographic follow-up during orthodontic treatment is recommended.

**Key words:** Apical root resorption, fixed appliances, risk factors.

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**Corresponding author:** Monika Chib, MDS, Department of Orthodontics & Dentofacial Orthopedics, Government Dental College & Hospital, Srinagar, Jammu & Kashmir, India

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#### INTRODUCTION

Apical root resorption (ARR), a permanent loss of hard tissue on the root apex of a tooth, is one of the most undesirable side effects during orthodontic treatment. The prevalence of ARR varies from 20 to 100% among orthodontic patients.<sup>1</sup>

External apical root resorption (ARR) is an undesirable complication of orthodontic treatment that results in permanent loss of tooth structure from the root apex.<sup>2</sup> However, it can be avoided with more accurate management of orthodontic treatment.<sup>3</sup> The literature indicates that patients undergoing orthodontic treatment are more likely to have severe ARR. The etiology of ARR is multifactorial; these factors consist of individual biologic characteristics, genetic predisposition and the effect of orthodontic forces. Risk factors for ARR can be categorized as patient-related and treatment-related.<sup>4</sup> Patient-related factors include; genetics, systemic factors, asthma and allergies, chronic alcoholism, the severity of

malocclusion, tooth-root morphology, a previous history of root resorption, alveolar bone density, root proximity to cortical bone, endodontic treatment, and patient age and sex. Orthodontic treatment-related risk factors include; the treatment duration, magnitude of applied force, direction of tooth movement, amount of apical displacement, and method of force application.<sup>5</sup> Fixed appliances have been the mainstream for orthodontic treatment. It has been found that the type of fixed appliances used for orthodontic treatment was associated with the incidence of ARR.<sup>6</sup> The present study was conducted to assess prevalence of apical root resorption during orthodontic treatment.

#### MATERIALS & METHODS

The present study was conducted among 100 patients of both genders (53 females and 47 males) who had undergone orthodontic treatment. The study material was selected from the archives of the Department of

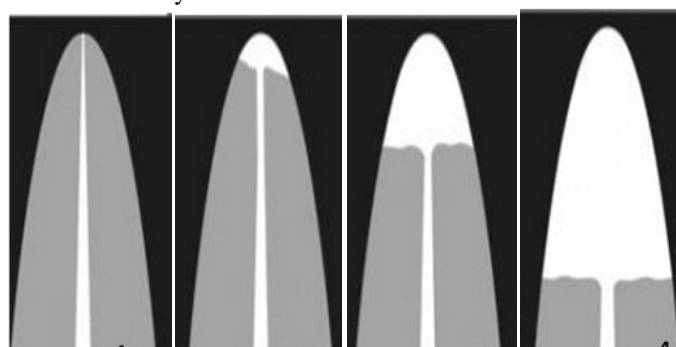
Orthodontics & Dentofacial Orthopedics, Government Dental College & Hospital, Srinagar.

The pre- and post-treatment panoramic radiographs of 100 patients who met the following inclusion criteria were used: anamnesis, treatment planning, and clinical procedure sheets properly filled in; permanent dentition or at least one of the molar or incisor teeth with complete root formation; no history of previous orthodontic treatment or dental trauma; no craniofacial anomalies, systemic disorders (such as chronic asthma, thyroid dysfunction, etc.) or parafunctional habits (bruxism, tongue thrusting, etc.). The pre-adjusted edgewise appliances (MBT 0.022 ) were used for all fixed orthodontic treatments.

Panoramic radiographs were obtained using the same NewTom GIANO NNT Scanner, following the manufacturer's instructions in a standard manner. All the radiographs were evaluated by the same

investigator. After four weeks, all the measurements of 40 randomly selected patients were repeated, and inter-observer variability was assessed. The post-treatment root lengths of all the teeth were compared with the root lengths on the pre-treatment panoramic radiographs. The index suggested by Malmgren et al<sup>7</sup> and modified by Sharpe et al<sup>8</sup> was accepted as a visual qualitative method used to assess the degree of OIIEARR due to its broad acceptance and applicability (Figure 1).

- Degree 0: the absence of resorption
- Degree 1: resorption of up to 2 mm of the root length
- Degree 2: resorption from 2 mm up to 1/3 of the root length
- Degree 3: severe root resorption, >1/3 of the root length



**Figure 1**

In order to determine potential risk factors, the following variables were assessed: the age at the beginning of treatment, gender, treatment type (the use of active removable appliances before fixed appliances or not, with or without extraction), and treatment duration (with removable appliances, with fixed appliances, and total treatment duration).

All the statistical analyses were performed using SPSS 23.0. In-class correlation coefficients were calculated to assess inter-observer variability with Cronbach's alpha. The gender distribution of the

patients was assessed by frequency analysis. Pearson's chi-squared test was used to determine the OIIEARR-gender and OIRR-treatment type relationships. Independent-samples t-tests were applied to analyze the means and distributions of the pre-treatment ages of the patients and the distribution of OIIEARR in different dental arches and tooth groups. The relationships between OIIEARR and total treatment duration and between treatment duration and fixed appliances were analyzed by one-way ANOVA. All the values were considered significant at  $P < 0.05$ .

**RESULTS**

**Table I Total and fixed orthodontic treatment durations of male and female patients**

Gender	No. of patients	Total treatment duration(months, mean ± SD)	P value	Fixed orthodontic treatment duration (months, mean ± SD)	P value
Male	47	24.6±5	0.009*	27.1±9.2	0.063
Female	53	20.8±4.5		23.1±9	

\* $P < 0.05$ , one-way ANOVA.

**Table II Prevalence of apical root resorption in different teeth**

Parameters	Prevalence in males	Prevalence in females	P value
Maxillary central incisor	85%	80%	0.02
Maxillary lateral incisor	86%	82%	0.04
Maxillary canine	74%	68%	0.01
Mandibular central incisor	80%	78%	0.05
Mandibular lateral incisor	83.2%	79.8%	0.03
Mandibular canine	70%	67%	0.02

Average	79.7%	75.8%	0.01
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Table II shows that apical root resorption of maxillary central incisor was 85% in males and 80% in females, maxillary lateral incisor was 86% in males and 82% in females, maxillary canine was 74% in males and 68% in females, mandibular central incisor was 80% in males and 78% in females, mandibular lateral incisor was 83.2% in males and 79.8% in females, mandibular canine was 70% in males and 67% in females and average value was 79.7% in males and 75.8% in females. The difference was significant ( $P < 0.05$ ).

## DISCUSSION

ARR occurs in different degrees. Severe ARR is defined as a shortening that is more than 4 mm or one-third of the root length and is observed in 1% - 5% of teeth.<sup>9</sup> Histologic research indicates an extremely high (more than 90%) occurrence of root resorption that is caused by orthodontic forces.<sup>10</sup> However, radiological incidence is lower than histological incidence. Severe ARR is rare with an incidence between 1 and 5% but the resorption can be more than 5 mm or one-fourth of root length.<sup>11</sup> ARR can cause an imbalanced ratio of crown and root in the affected teeth, and even teeth loss, affecting patients' quality of life and orthodontic treatment result.<sup>12</sup> The present study was conducted to assess prevalence of apical root resorption during orthodontic.

Since external apical root resorption was first reported as an unfavorable side effect of orthodontic treatment by Ottolengui in 1914,<sup>13</sup> several studies and reviews on this issue have been published. Factors such as orthodontic treatment type, orthodontic force type and magnitude,<sup>14,15</sup> treatment duration, pre-treatment patient age, and gender have been associated with OIIEARR. Panoramic radiographs, which had been routinely taken before and after orthodontic treatments, were used in this study to assess root resorption.

In the present study, 46.3% of orthodontically treated patients exhibited OIIEARR of different degrees, and the incidence of severe resorption (with degrees 2-3) was 10.8%, regardless of the treatment or patient-related variables. The highest incidence of root resorption in the literature was reported by DeShields,<sup>16</sup> who found root resorption in 99.08% of patients. Pastroet al reported that increased OIIEARR risk in adult patients is associated with an increased incidence of chronic periodontal diseases.<sup>17</sup> However, many studies did not find any association between chronological age and root resorption.

In the present study, the frequency of root resorption was found to be higher in the males than females. The treatment duration was also longer in males which can be attributed to the longer pubertal period and low compliance. Levander et al<sup>18</sup> and Kjaer<sup>19</sup> found a greater prevalence of OIIEARR in females than males. In contrast, Baumrind et al<sup>20</sup> reported a higher prevalence of OIIEARR in males, consistent with the present study. Jung & Cho,<sup>21</sup> Pastro et al,<sup>17</sup> and McFadden et al<sup>22</sup> found no relationship between gender and OIIEARR prevalence.

Consistent with the results of other studies,<sup>21,23,24,25</sup> of all the tooth groups, the maxillary incisors were more likely to exhibit OIIEARR in the present study. The

cortical bone of the socket, the proximity between the roots of maxillary central and lateral incisors, the alveolar bone on the buccal surface, the incisive canal, and intrusion and retraction movements are thought to be responsible for the high resorption potential of these teeth.<sup>21</sup> Mandibular incisors were found to exhibit OIIEARR after maxillary incisors in the present study. McFadden et al<sup>22</sup> reported that mandibular incisors are more likely to undergo root resorption after intrusion movement than the maxillary incisors.

## CONCLUSION

The incidence of severe root resorption after orthodontic treatment was 10.8% in the present study. Significantly related risk factors were prolonged treatment duration and treatment with extraction. Since root resorption is a multifactorial phenomenon, care should be taken to prevent it by routine radiographic examination of the patients undergoing orthodontic treatment and by keeping the treatment mechanics simple and precise.

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