

Root resorption after orthodontic treatment in high- and low-risk patients: analysis of allergy as a possible predisposing factor

P. Owman-Moll* and J. Kurol**

Faculties of Odontology, *Göteborg and **Malmö, Sweden

SUMMARY The development of excessive root resorption during orthodontic tooth movement is an adverse side-effect, which is of great concern. The aim of this investigation was to analyse factors that might be associated with orthodontically induced root resorption. After buccal movement of maxillary premolars in 96 adolescents, the experimental teeth were extracted and subjected to histological analysis and measurement of resorbed root area. Fifty individuals, 18 boys and 32 girls, mean age 13.4 years, were selected and divided into two equal groups: the high-risk group based on measurements of the most severe root resorptions, and the low-risk group on measurements of mild or no root resorptions.

After a preliminary screening of possible risk factors regarding root resorption, i.e. root morphology, gingivitis, allergy, nail-biting, medication, etc., only those subjects with allergy showed an increased risk of root resorption, but this was not statistically significant.

Introduction

Root resorption is a common sequela of orthodontic treatment and has been recorded in 93 per cent of treated adolescents (Kurol *et al.*, 1996). Moderate to severe apical root resorptions (>2 mm to <1/3 of the root length) have been found in 12–17 per cent of orthodontically treated patients (Hollender *et al.*, 1980; Linge and Linge, 1991) and excessive root resorptions (>1/3 of the root length) in 1–5 per cent (Levander and Malmgren, 1988; Davidovitch, 1996). However, after buccal movement of maxillary premolars with a clinically relevant force of 50 cN, histological examinations showed that some apical root resorptions had reached halfway or more to the pulp after only 3 weeks (Kurol *et al.*, 1996).

A series of clinical, standardized studies in adolescents have been carried out to investigate the association between orthodontic tooth movement, early induced root resorption and the duration of applied force (Owman-Moll, 1995), the magnitude of applied force (Owman-Moll

et al., 1996a,b), and type of applied force (Owman-Moll *et al.*, 1995). However, the results were ambiguous, and the individual variations were considerable. Since the adolescent patients were rather homogeneous regarding age, dental development, and malocclusion, the variations recorded indicated a genuine individual variation. Thus, root resorption related to orthodontic treatment seems to be a multifactorial problem. Besides mechanical factors (Linge and Linge, 1983; Levander and Malmgren, 1988; Kalley and Phillips, 1991; Costopoulos and Nanda, 1996), biological factors that might affect root resorption have also been discussed in the literature, e.g. root morphology (Levander and Malmgren, 1988; Kjær, 1995; Mirabella and Årtun, 1995a; Lee *et al.*, 1999), pre-treatment root resorption (Massler and Malone, 1954; Goldson and Henrikson, 1975; Kalley and Phillips, 1991), endodontically treated teeth (Wickwire *et al.*, 1974; Remington *et al.*, 1989; Spurrier *et al.*, 1990; Mirabella and Årtun, 1995a,b), gingivitis, allergy, asthma, arthritis, and diabetes (Davidovitch *et al.*, 1995; Davidovitch, 1996), gender (Massler

Table 1 Some local and systemic factors which might be associated with an increased (+) or decreased (–) risk of root resorption during orthodontic treatment.

Factors	References
Dental health	
Root morphology, e.g. pipette shaped, blunt, abrupt root deflection, narrow root, taurodontism	Levander and Malmgren (1988) (+) Kjær (1995) (+) Mirabella and Årtun (1995a) (+) Lee <i>et al.</i> (1999) (+)
Tooth agenesis	Kjær (1995) (+) Lee <i>et al.</i> (1999) (+)
Pre-treatment root resorption	Massler and Malone (1954) (+) Goldson and Henrikson (1975) (+)
Endodontically treated teeth	Wickwire <i>et al.</i> (1974) (+) Spurrier <i>et al.</i> (1990) (–) Mirabella and Årtun (1995a,b) (–)
Oral health	
Gingivitis	Davidovitch <i>et al.</i> (1995) (+) Davidovitch (1996) (+)
Medical health	
Allergies	Davidovitch <i>et al.</i> (1995) (+)
Asthma	Davidovitch (1996) (+)
Arthritis	
Diabetes	
Habits	
Nail-biting	Odenrick and Brattström (1983) (+)
Lip/tongue dysfunction	Linge and Linge (1991) (+)
Medication	
Aspirin	Kameyama <i>et al.</i> (1994) (–)

and Perreault, 1954; Massler and Malone, 1954; McFadden *et al.*, 1989), habits, i.e. nail-biting (Odenrick and Brattström, 1983), and lip/tongue dysfunction (Linge and Linge, 1991). A connection between tooth agenesis and a tendency to orthodontically induced root resorption has been reported (Kjær, 1995; Lee *et al.*, 1999). Drugs may also play a role, and Kameyama *et al.* (1994) reported, from an investigation in rats, that administration of aspirin might inhibit root resorption induced by mechanical injury of the periodontal tissue. Some local and systemic factors that might be associated with an increased or decreased risk of root resorption are listed in Table 1. The factors behind the individual variation might be elucidated in a comparison of orthodontically treated patients identified as extremely high- or low-risk individuals regarding root resorption within the same experimental group.

In a pilot study of 20 orthodontically treated individuals with a high- or low-risk root resorption

pattern, several local and systemic factors that might increase or decrease root resorption were analysed, e.g. root morphology, such as pipette-shaped, blunt, abrupt deflection or narrow roots, tooth wear, pre-treatment root resorption, gingivitis, allergy, asthma, arthritis, diabetes, nail-biting, and aspirin medication. Only allergy showed clearly increased prevalence of root resorption. Therefore, it was decided to increase the number of subjects and study the possible influence of allergy on the increased risk of orthodontically induced root resorption.

The purpose of this investigation was to analyse root resorption pattern in orthodontically treated adolescents with respect to allergy.

Materials and methods

The patient material, i.e. histological, longitudinal sections from maxillary premolars, was collected from four previous investigations in

adolescents (Owman-Moll *et al.*, 1995, 1996a,b; Kurol *et al.*, 1996). The first or second maxillary premolars in 96 individuals had been moved buccally with a fixed orthodontic appliance (Kurol *et al.*, 1996). A lingual arch with an anterior bite-block was inserted to reduce the occlusal forces on the test tooth and to increase the anchorage. A well-controlled and weekly reactivated force of 50, 100, or 200 cN was applied on one side or the other of the maxilla when the experimental periods varied between 1 and 7 weeks. There were eight individuals in each experimental group. Although the investigations were standardized with regard to dental development and mal-occlusion, there were large individual variations. In some subjects the resorbed root area was almost five times larger (high-risk) compared with other patients (low-risk), although the magnitude and duration of force had been the same. The individuals with the highest and lowest scores for root resorption expressed as resorbed root area in each group were selected for the present study, i.e. 50 individuals, 18 boys and 32 girls with a mean age of 13.4 years.

Resorbed root area (arbitrary units) was defined as the sum of the resorbed root area (Figure 1: length \times depth of the resorption lacuna) of all

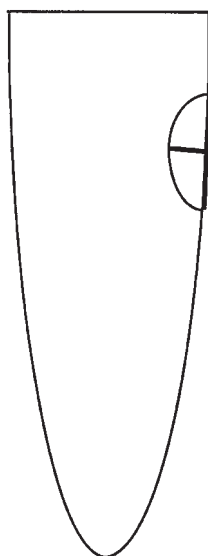


Figure 1 Illustration of measurement of resorbed root area (length \times depth in arbitrary units) on histological sections.

root resorptions in three bucco-palatally directed histological sections of each tooth. A mean value was calculated and related to a mean root area of the histological sections. The outlining of resorbed root surface had to be estimated. The high-risk individuals revealed, on average, 4.5 times higher scores for resorbed root area compared with individuals in the low-risk group. The measuring procedures have been described previously (Kurol *et al.*, 1996).

The patient interviews were performed by one of the authors (P.O.M.). As positive answers concerning allergies may be given since subjects may believe they are allergic, a differentiation was made between self-reported allergy, and when the allergy was verified by on-going medication or following consultation with a physician.

Statistics

A Chi-square test was used to investigate the possible influence of allergy on root resorption during orthodontic tooth movement.

Results

This study did not show any unequivocal association between the investigated variables except a higher prevalence for allergy, but this was not statistically significant (Table 2).

The prevalence of allergies was high in the patients studied with more than every second individual (54 per cent) reporting periodic episodes of allergy; 14 subjects in the high-risk group and 13 individuals in the low-risk group. When the reported allergies were related to on-going periodic medication or a history of consultation with a physician, the frequency was

Table 2 The prevalence of allergy in subjects within the high/low-risk groups with respect to root resorption.

Allergy	Subjects (<i>n</i>)	
	High risk	Low risk
Self-reported	14	13
Verified	12	6

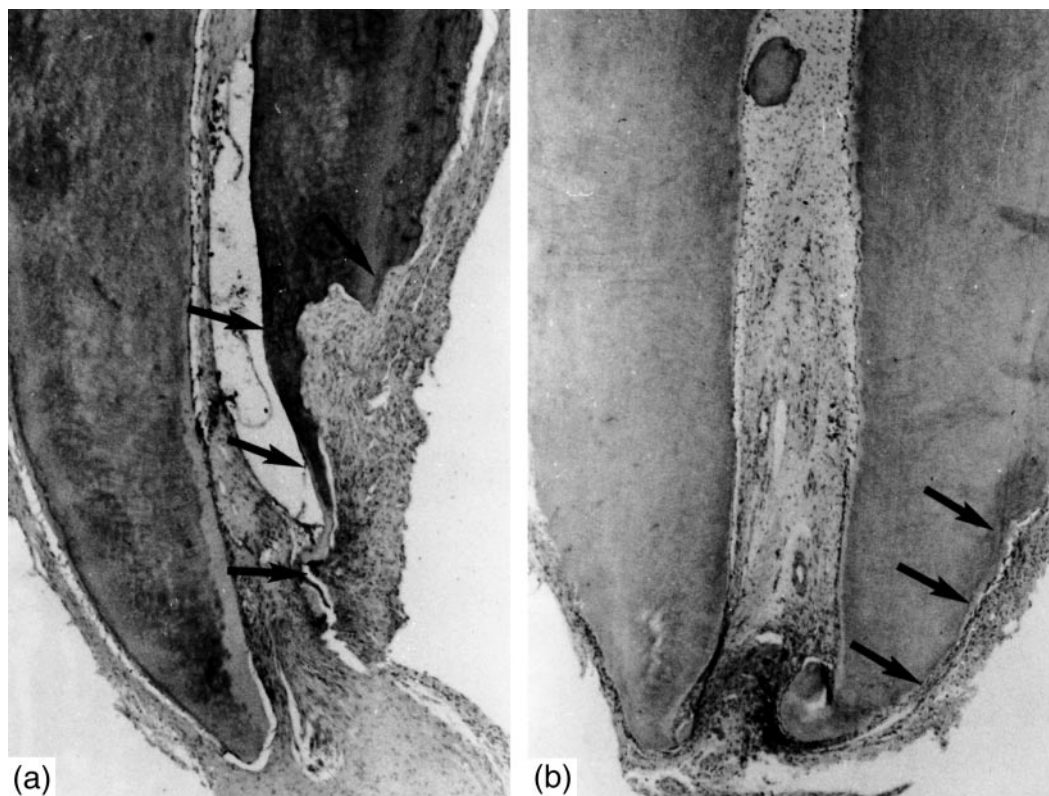


Figure 2 Histological sections from the apical area of two maxillary premolars, in subjects with identical treatment; a buccally directed force of 50cN for 3 weeks. (a) From a high-risk patient; the resorption (arrows) had almost reached the pulp. (b) From a low-risk patient; intact root surface (arrows) without any root resorption.

36 per cent: 12 individuals in the high-risk group and six subjects in the low-risk group. The allergens were, e.g. grass, pollen, furry animals, nickel, mites, mould and food. Medication with different types of antihistamine was reported by all but four patients.

Chi-square tests did not reveal any significant association between allergy and orthodontically-induced root resorption either in the high- or low-risk patients.

Discussion

Recent studies in adolescents (Kurol *et al.*, 1996; Owman-Moll 1995; Owman-Moll *et al.*, 1995, 1996a,b) have indicated that individual factors play an important role in the development of

orthodontically induced root resorptions. This may be illustrated in Figure 2, which shows the apical part of two maxillary premolars after buccal movement with 50cN for 3 weeks. The high-risk patient revealed an apical resorption that had reached almost into the pulp, while the low-risk patient did not show any root resorption, although the magnitude and duration of force had been the same. In this investigation, with patients selected according to histologically documented high- or low-risk of root resorption within the same experimental group, the individual susceptibility to root resorption could not be explained by allergy alone.

It has been hypothesized that allergy might be an aetiological factor in increased root resorption induced by orthodontic forces (Davidovitch

et al., 1995; Davidovitch, 1996). The occurrence of inflammation in the periodontal ligament in the early stage of tooth movement and the presence of activated leucocytes, which originate in diseased organs and tissues in the peripheral blood, supports a possible association between root resorption and certain pathological conditions (Davidovitch *et al.*, 1988). In the present investigation, allergy, which is an ever-increasing problem, was the most frequent possibly associated factor for increased risk of root resorption. More than every second patient ($n = 27$), with a slight predominance in the high-risk group compared with the low-risk group (14 and 13, respectively), reported being allergic mainly to pollen and furry animals. Supplementary questions regarding consulting a doctor and/or medication, showed the prevalence to be 36 per cent. This is in agreement with the estimated prevalence of allergies in Swedish adolescents (Hattevig *et al.*, 1987; Croner and Kjellman, 1990; Lindsten and Kurol, 1997).

Previous investigations concerning analysis of risk factors for increased root resorption in humans are based on radiographic evidence such as intra-oral radiographs (Becks, 1936, 1939; Massler and Malone, 1954; Phillips, 1955; Goldson and Henrikson, 1975; Malmgren *et al.*, 1982; Linge and Linge, 1983, 1991; Levander and Malmgren, 1988; McFadden *et al.*, 1989; Remington *et al.*, 1989; Kjær, 1995; Mirabella and Årtun, 1995a,b; Lee *et al.*, 1999), panoramic radiographs (Kalley and Phillips, 1991; Kjær, 1995) or lateral cephalograms (Phillips, 1955; McFadden *et al.*, 1989; Mirabella and Årtun, 1995a; Lee *et al.*, 1999). Whilst apical root resorptions can be seen on radiographs, to diagnose root resorption on the buccal and palatal surfaces of the root, the radiograph is an inadequate tool (Andreasen *et al.*, 1987; Chapnick, 1989). Histological findings are more pronounced than the radiographs would suggest (Wehrbein *et al.*, 1995; Owman-Moll, 1995; Owman-Moll *et al.*, 1995, 1996a,b; Kurol *et al.*, 1996). The patient material in this study was selected from previous histological investigations (Kurol *et al.*, 1996; Owman-Moll *et al.*, 1995, 1996a,b), which provided a unique opportunity to select high- and low-risk patients regarding root resorption, and analyse the

influence of certain variables on individual disposition to resorption.

Becks (1936) stated that orthodontically induced root resorptions were not produced by mechanical force alone, but were the result of individual predisposition due to endogenous factors. Systemic factors were considered the key to severe root resorptions after orthodontic treatment. In a later study, this association could not be confirmed when blood tests were analysed (Newman, 1975). However, no distinction was made between the cause of root shortening, i.e. root resorption or developmental disturbance. From a radiographic investigation in man Linge and Linge (1983), reported a marked variation of root resorption in teeth in the same individual. This observation made them hesitant about the role of factors such as diet and hormone balance in increasing the risk of root resorption. However, several investigations have reported that the susceptibility to resorption varies from tooth to tooth. The maxillary central incisors have been regarded as the most sensitive to root resorption (Becks, 1936; Newman, 1975; McFadden *et al.*, 1989; Kalley and Phillips, 1991), closely followed by maxillary premolars and lateral incisors (Newman, 1975).

Conclusions

A screening of 20 individuals with previously ascertained high or low root resorption response to orthodontic force of the same magnitude, duration, and type revealed that allergy might play a role. In expanded material of 50 individuals, the results were suggestive of a link between allergy and the extent of root resorption, but no statistically significant difference was found between the relevant groups.

Address for correspondence

Dr Py Owman-Moll
Department of Orthodontics
Göteborg University
Box 450
SE-405 30 Göteborg
Sweden

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