

Comparison of Australian and American orthodontic clinical approaches towards root resorption

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Aims: As part of The Rocky Mountain Travelling Fellowship, a pilot survey was conducted to assess current diagnostic and clinical approaches to the management of orthodontic patients in relation to root resorption.

Methods: Groups comprising Australians (Sydney, New South Wales) and North Americans (Los Angeles, California), in two stages of their orthodontic careers (post-graduate orthodontic students from the University of Sydney and University of Southern California and qualified practising orthodontists) were asked to complete a questionnaire. The questions examined diagnosis and management approaches related to root resorption used in their clinical practice.

Results: Replies demonstrated that there were differences in management depending on operator experience and the country of clinical practice. However, a summarised common approach to orthodontic root resorption comprised (1) the use of an orthopantomogram as a screening diagnostic tool, followed by periapical radiographs for those perceived as 'higher risk' patients, particularly individuals with a history of root resorption; (2) a six monthly radiographic review during treatment; (3) the use of light forces and/or rest periods (discontinuous forces) every two to three months; (4) the extraction of deciduous teeth if permanent successors were erupting ectopically and causing damage to adjacent root structures; and (5) the use of fixed retention after treatment.

Conclusion: This project was intended to initiate discussion and form a basis for further investigation into the clinical management of orthodontic root resorption.

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Introduction

Root resorption resulting from orthodontic treatment is an unpredictable adverse sequela, involving transient inflammatory surface resorption.¹ The process is likely to be influenced by complex and multiple factors.²

Risk factors governing the incidence of root resorption have been reported to include: individual susceptibility, genetics, hormonal imbalance, an adverse medical history, nutritional imbalance, age, dental history, tooth type, the duration of orthodontic treatment, the amount of tooth movement, appliance type, the type of tooth movement and the magnitude of applied orthodontic force.³

Currently, there is no consensus regarding the prevention of root resorption. However, treatment strategies have been suggested in an attempt to minimise its impact. These include: limiting treatment duration,⁴ using light intermittent forces,⁵ the careful assessment of medical history and familial tendency,⁶ the control of habits⁷ and, if required, the cessation of treatment.¹

Unwanted orthodontic related root resorption has direct implications for clinical practice. The identification of patients with increased susceptibility, their management during treatment, retention and follow-up protocol remains the responsibility of the orthodontist.⁸ However, many general dentists

and non-orthodontic specialists perceive that root resorption is avoidable and is under the control of the clinician through patient management. Furthermore, since dentists may be challenged by providing restorative options to post-orthodontic patients who have suffered root resorption,⁹ a professional approach should ideally be universal, uniform and evidence-based.

No specific clinical approach to the orthodontic management root resorption has been established.^{8,9} Even though there is a relatively high incidence of orthodontic root resorption, treatment options are generally case-dependent. Furthermore, there is a lack of high level evidence⁹ and currently, the clinician's experience¹⁰ and perception,¹¹ in conjunction with the evaluation of individual patient factors, determines the most suitable therapeutic approach.¹² It has been suggested that future research should aim to provide evidence for practitioners and patients which enables informed and improved decisions regarding appropriate management options.⁹

The aim of the present study was to assess current diagnostic and clinical approaches to the management of orthodontic patients in relation to root resorption. A pilot survey compared practitioners from two different countries (America and Australia) and in two different stages of their orthodontic careers (post-graduate orthodontic students and qualified practising orthodontists). It was anticipated that the survey responses would initiate discussion and identify a universal approach to the management of orthodontic root resorption and provide an evidence-based foundation for clinical practice.

Materials and methods

This cross-sectional study involved participants from the United States of America (Los Angeles, California) and Australia (Sydney, New South Wales). From each country, two professional groups representing different stages of orthodontic experience, post-graduate students (University of Southern California and University of Sydney) and registered specialist orthodontists from both countries, were sampled. The qualified orthodontists worked in hospital-based service or private practices and had past or current faculty involvement. All students who were enrolled in post-graduate programs in both countries were recruited.

The university orthodontic faculties were comparable. All students were enrolled in three-year full-time training programs. The universities were hospital-based and required the treatment of patients from the commencement of their respective courses. In addition, tutorial-based theory education was provided throughout the programs. Therefore, it was expected that all student participants would be able to answer the clinically-based survey questions.

A single part survey was designed with a series of fixed questions and responses selected from four to seven alternatives. Participants were able to choose more than one alternative to best describe their answer. In addition to the fixed responses, there was an option to add further information in seven of the sixteen questions. This critical incident questionnaire approach focussed participants onto a particular issue but provided an opportunity to express ideas, with minimal direction in order to establish their perspective.¹³

The surveys were distributed in person directly to participants. One survey per student was provided to the 17 American and the 12 Australian orthodontic post-graduate students. Orthodontists visiting the respective post-graduate training dental hospital and faculty departments over a 4-week period were given surveys. The majority completed the 30 minute-survey upon receipt. A covering letter accompanying each survey informed participants of the purpose of the survey and that data would remain anonymous and confidential. Consent to conduct the survey was granted by the respective heads of orthodontic departments.

Personal data from respondents was de-identified. Respondent numbers in each group were: University of Southern California post-graduate orthodontic students (American Students), N = 17 (27%) of total sample; University of Sydney post-graduate orthodontic students (Australian Students), N = 10 (16%); American orthodontists, N = 16 (25%); Australian orthodontists, N = 20 (32%), making a total of 63 participants.

The survey comprised questions relating to pre-orthodontic diagnosis of root resorption, management during orthodontics, including treatment planning options, and post-orthodontic retention (Figure 1).

Data for each item were analysed by determining frequency of distributions and percentages. Percentage

Please tick the appropriate box/boxes which best represent your response.

1. Please indicate which best describes your current orthodontic position:
 - ☐ The University of Sydney, Australia. Post-graduate orthodontic student (Specialist Training Program)
 - ☐ The University of Southern California, USA Post-graduate orthodontic student (Specialist Training Program)
 - ☐ Australian Private Practice
 - ☐ USA Private Practice
 - ☐ Australian Public/Hospital Practice
 - ☐ USA Public/Hospital Practice
 - ☐ Other. Please specify
2. Years since graduation from orthodontic specialist training (if applicable)?
 - ☐ <1 to 5 years
 - ☐ 5 to 10 years
 - ☐ 10 to 20 years
 - ☐ >20 years
3. What method(s) do you use in clinical practice to assess for risk of orthodontic root resorption?
 - ☐ Previous dental history
 - ☐ Clinical examination
 - ☐ Orthopantomogram
 - ☐ Periapical radiograph
 - ☐ Computer Tomography imaging
 - ☐ Other. Please specify
4. In what situations would you take additional precautions for a patient (where there is perceived increased risk of susceptibility to orthodontic root resorption)?
 - ☐ History of trauma to dentition
 - ☐ Previous root resorption
 - ☐ Family history of root resorption
 - ☐ Transplanted tooth
 - ☐ Medical condition. Please specify
 - ☐ Other
5. What method(s) do you use in clinical practice to screen for (detect) orthodontic root resorption?
 - ☐ Clinical examination. Please specify
 - ☐ Orthopantomogram
 - ☐ Periapical radiograph
 - ☐ Computer Tomography imaging
 - ☐ Other. Please specify
6. If orthodontic root resorption were noted, during initial consultation or any stage of treatment, what periodic follow-up assessment methods would you conduct?
 - ☐ Orthopantomogram
 - ☐ Periapical radiograph
 - ☐ Computer Tomography imaging
 - ☐ Clinical examination (e.g. mobility, colour changes)
 - ☐ No follow-up
 - ☐ Other
7. How often would you follow-up a case presenting with orthodontic root resorption once noted?
 - ☐ Monthly
 - ☐ Three monthly
 - ☐ Six monthly
 - ☐ Yearly
 - ☐ Approximately half-way through treatment
 - ☐ End of treatment
 - ☐ No follow-up
 - ☐ Other. Please specify
8. How do you classify orthodontic root resorption (what description method do you use to record the severity of root resorption for future comparison)?
 - ☐ Loss of root in millimetres/inches
 - ☐ Loss of root in percentage
 - ☐ Description (mild/moderate/severe)
 - ☐ Diagram
 - ☐ Mobility
 - ☐ Other. Please specify
9. Which best describes your clinical management of an orthodontic patient where there is generalised loss of one-third OR more than 4 mm of the tooth roots due to resorption?
 - ☐ Finish your treatment immediately
 - ☐ Interrupt the treatment for a time, then continue at a later stage
 - ☐ Use very light wires/forces to finish the treatment
 - ☐ Other. Please specify
10. If you note the presence of severe root resorption when would you inform the patient and/or parent(s)?
 - ☐ Immediately
 - ☐ At the end of treatment
 - ☐ Only if it becomes worse
 - ☐ Never
11. What is your choice of retainer where severe root resorption is present?
 - ☐ Removable Hawley type
 - ☐ Removable Begg type
 - ☐ Thermoplastic retainer
 - ☐ Fixed wire retention
 - ☐ Other. Please specify
12. Is the above retainer used the same as your routine/standard retention protocol?
 - ☐ Yes
 - ☐ No
 - ☐ Other comments
13. Which best describes your preferred management of a patient case where the erupting canines represent risk for lateral and/or central incisors?
 - ☐ Extract the primary canines if present
 - ☐ Extract the permanent (secondary) canines
 - ☐ Expose the canine
 - ☐ Move the incisor(s) away
 - ☐ Wait and see (periodic monitoring)
 - ☐ Other comments
14. Which best describes your preferred management of a patient case where the erupting canines have resorbed one-third of the root of the lateral and/or central incisor(s)?
 - ☐ Extract the erupting canine
 - ☐ Expose the canine and monitor
 - ☐ Expose the canine and commence orthodontic traction
 - ☐ Orthodontics to move the incisor(s) away
 - ☐ Monitor
 - ☐ Other. Please specify
15. Which best describes your management of a patient case where there is a need for extraction treatment and full-fixed orthodontic appliances, however generalised root resorption is present?
 - ☐ Do not recommend treatment; advise against commencement of orthodontic treatment indefinitely
 - ☐ Do not recommend treatment for now; advise against commencement of orthodontic treatment, however, plan for future recall and reassessment for treatment at a later stage
 - ☐ Offer non-extraction orthodontic treatment and camouflage discrepancy where possible
 - ☐ Offer extraction treatment, but modify treatment approach by waiting for migration of the teeth following extractions, prior to application of orthodontic traction/force
 - ☐ Extract and continue as routine case
 - ☐ Other. Please describe
16. Which best describes your management of a patient case where you have diagnosed severe root resorption and where there are remaining extraction sites to be closed?
 - ☐ Stop treatment immediately and remove all appliances
 - ☐ Interrupt treatment for a period of time. Then continue
 - ☐ Continue, adapting to treatment mechanics to only involve 'light forces'
 - ☐ Continue, only to space closure and cease treatment thereafter

Figure 1. RMO Travelling Fellow Research Project. Questionnaire on orthodontic root resorption.

was based on the total number of responses for subjects within each group. Where descriptive responses were permitted, key themes were derived from comments and codes which noted similarities of responses were developed. To check the original responses for interpretive credibility, a blind thematic analysis was discussed with an orthodontist independent of the study. Validity was enhanced by not disclosing the orthodontic position or year since graduation of the subject making the comment.

Results

The analysis rate for the volunteers who returned the surveys was 100% for orthodontists and University of Southern California post-graduate orthodontic students and an 83% response rate for University of Sydney post-graduate orthodontic students. Of the sample, 57% were orthodontists. Over half of the American orthodontists had been in practice for at least 20 years, 18.8% for 10-20 years and 31% for 5-10 years. The largest proportion of the Australian orthodontist sample group had been practising for 5-10 years (40%). The remainder had been in practice 20 years (30%), 10-20 years (25%) and 1-5 years (5%), respectively.

All participants responded with more than one answer to the survey questions, although few used the option of further elaboration even when the 'other' response was chosen.

Responses relating to pretreatment diagnosis and treatment planning questions revealed that all groups would use periapical radiographs to assess the risk of a patient to root resorption. All Australian orthodontists and students indicated that a panoramic radiograph (OPG) would be used, whereas only 46.67% of the American orthodontists and 35.29% of the American students would use OPGs. More than 80% of Australian orthodontists and students would use previous dental history as the most frequent method of evaluation following OPG and periapical radiographs. In contrast, American students reported computer tomography (CT) as their preferred method for root resorption assessment in clinical practice (Figure 2).

The most favoured method to screen all patients for root resorption was an OPG for Australian orthodontists and students. The majority of American orthodontists and students would use periapical radiographs. A substantial proportion of American

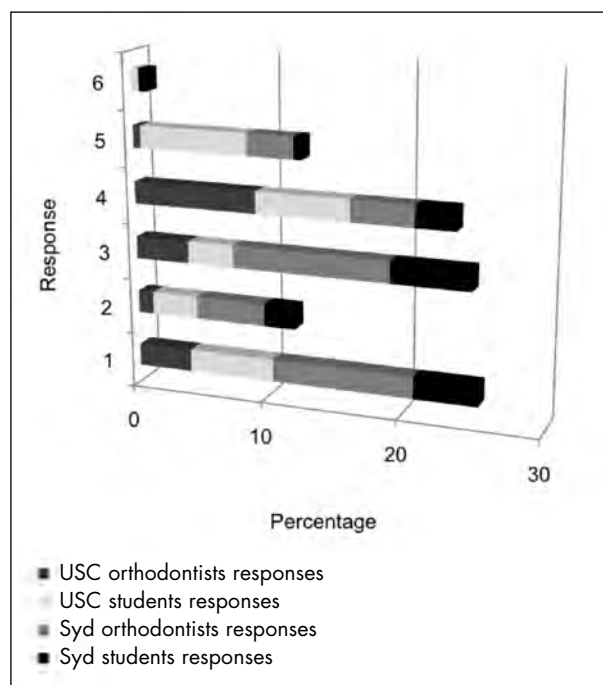


Figure 2. Methods used in clinical practice to assess risk of orthodontic root resorption.

Response answer 1: Previous history
 Response answer 2: Clinical examination
 Response answer 3: Orthopantomogram
 Response answer 4: Periapical radiograph
 Response answer 5: Computer tomography
 Response answer 6: Other

students (35%) cited computerised tomography as their assessment method method of choice, but only 5.88% of Australian students would employ this method.

Clinical screening and investigation was used to confirm the pre-orthodontic presence of root resorption. In addition, situations arose in which there was a perceived increased risk of susceptibility. All respondents agreed that previous root resorption posed an increased risk and indicated that additional precautions would be required. The next most commonly perceived risk factors were a history of trauma to the dentition and a family history of root resorption.

If root resorption was noted, both American groups indicated that their preferred method of recording severity would be measurement of millimetre loss of root structure (students 40%, orthodontists 28.9%). The majority of Australian students (28.6%) and orthodontists (32.5%) used the written description of mild/moderate/severe; however, both American

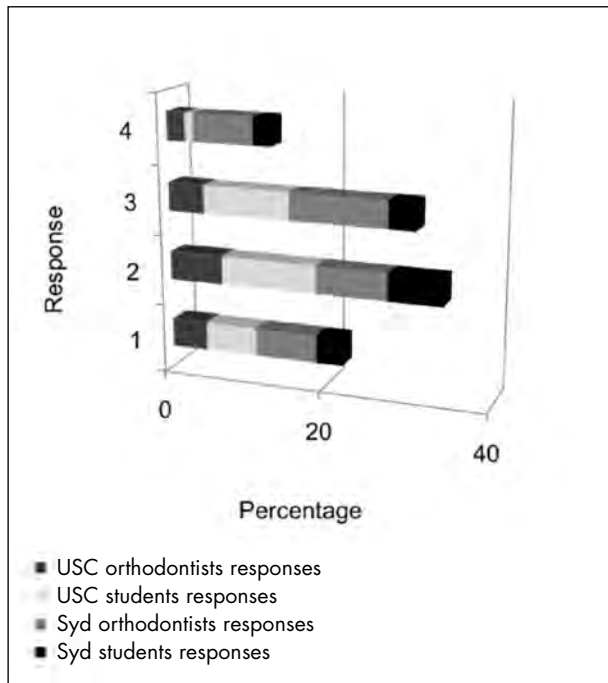


Figure 3. Approach to clinical management of orthodontic patients with generalised loss of one-third or four millimetres of tooth root loss due to resorption.

Response answer 1: Finish treatment immediately
 Response answer 2: Interrupt treatment, continue later
 Response answer 3: Use light wire/forces
 Response answer 4: Other

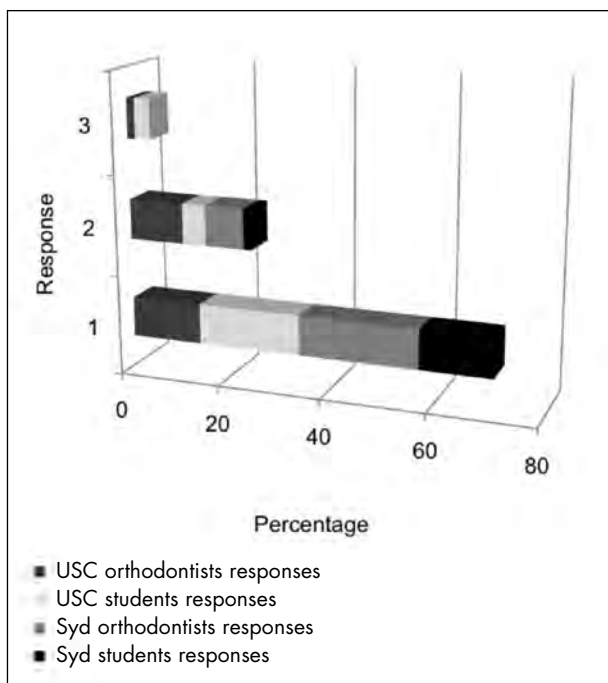


Figure 5. Comparison of retainer choice for routine vs root resorption cases.

Response answer 1: Yes, same retention
 Response answer 2: No, different retention
 Response answer 3: Other

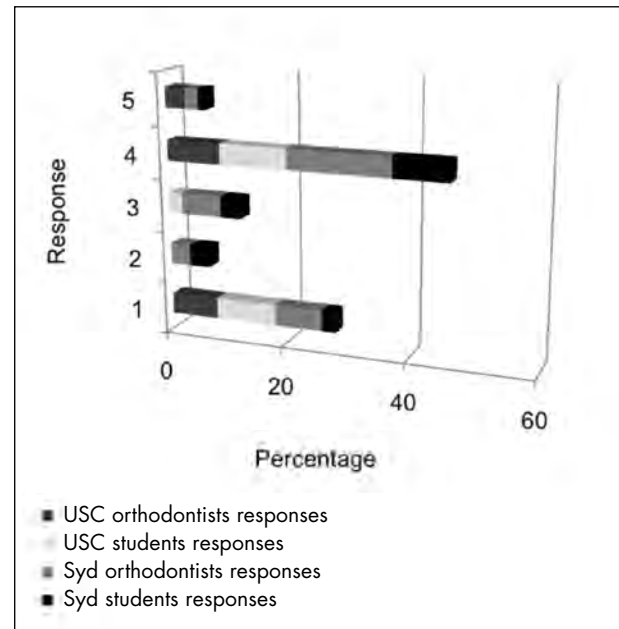


Figure 4. Retention method used for patients who have experienced root resorption during treatment.

Response answer 1: Removable Hawley type retainer
 Response answer 2: Removable Begg type retainer
 Response answer 3: Removable Thermoplastic retainer
 Response answer 4: Fixed Wire retention
 Response answer 5: Other

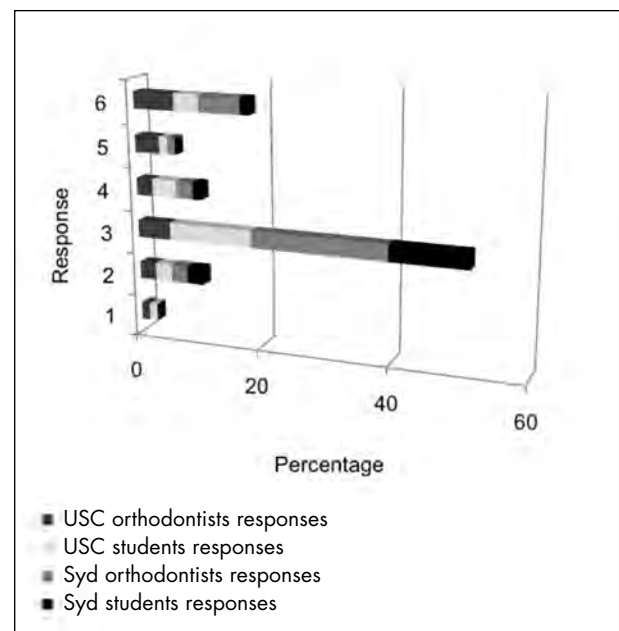


Figure 6. Preferred approach to management where erupting permanent canines have resorbed one-third of the incisor.

Response answer 1: Extract erupting canine
 Response answer 2: Expose canine and monitor
 Response answer 3: Expose canine and commence orthodontic traction
 Response answer 4: Orthodontics to move incisor(s) away
 Response answer 5: Monitor
 Response answer 6: Other

(28.9%) and Australian students (28.6%) indicated that they would also use the percentage of root lost. A record of mobility and diagrams were the least favoured in all groups.

Once root resorption was noted, all groups indicated that they would continually monitor the case. Students would generally review more frequently (monthly, American Students 4.5%, Australian Students 9%) than orthodontists (monthly, 0%). However, the majority of all groups preferred a three to six monthly review regimen. A minority of Australian orthodontists would check the root resorption yearly (8%).

The preferred method of screening for root resorption was reflected in the periodic review of patients who were noted to have root resorption. American groups continued to prefer periapical radiographs (American students 46%, American orthodontists 61.5%), whereas the majority of Australians in each group said they would use OPGs (Australian students 40%, Australian orthodontists 36.7%), in preference to alternate methods. OPGs and periapical radiographs were preferred by all groups. Orthodontists also considered the use of CT; however, no students said they would use this method for reviewing root resorption.

Participants were asked which best described their clinical management of a patient with one-third (4 mm) or more of tooth root loss due to resorption (during treatment). The majority of Americans (orthodontists 37.5%, students 39.3%) and Australian students (42.9%) would temporarily suspend treatment. In contrast, most of the Australian orthodontists (33.3%) would continue using light wires and forces to finish (Figure 3). In terms of providing information to patients, all respondents stated that they would inform the individual involved immediately.

Following cessation or the completion of orthodontic treatment in patients with resorption, the preferred retention method of all groups was fixed wire retention (Figures 4 and 5). The next most popular retainer was a removable Hawley appliance. The retention protocol used was also the routine/standard protocol used for other patients for all clinicians.

Treatment scenarios were presented to assess the clinicians' approach to certain clinical problems. If the erupting permanent canines represented a risk to the incisors, the extraction of the primary canines was

the management of choice. In circumstances in which a third of the incisor root has been lost as a result of resorption from an erupting canine, the exposure and commencement of orthodontic traction was the treatment of choice for the respondents in all groups (American students 50%, American orthodontists 23.5%, Australian students 69.2%, and Australian orthodontists 61.5%) (Figure 6).

The recommendations for patients with generalised resorption, in which there was a diagnostic need for extraction and full-fixed orthodontic treatment, differed between groups. The highest response from American orthodontists was to advise against the commencement of treatment (20%). In contrast, Australian orthodontists (37.9%) and students (30%) preferred to offer a non-extraction camouflage approach to management. A high number of students from America and Australia would modify their treatment approach by waiting for the migration of teeth following extraction before commencing active treatment. If an extraction case was already in treatment, but severe resorption was discovered, the majority in all groups would interrupt treatment for a period of time before continuing to completion.

Discussion

Approach to diagnosis

Diagnostic radiographic methods were used to assess root resorption. All respondents in the present study indicated that they would use periapical radiographs to assess the risk of root resorption in their orthodontic patients. This is in agreement with a previous study which compared Swedish and Greek orthodontists.¹¹ Panoramic radiographs were also a popular screening method. Convenience may be found in the routine use of this radiograph which is accepted for most orthodontic patient treatment planning. While radiation exposure is minimised with panoramic films, periapical radiographs offer greater clarity of root structure and features. However, OPGs may overestimate root loss by more than 20% when a comparison of pretreatment and post-treatment films is performed.¹⁴

Previous surveys and retrospective studies which have assessed clinical perception and guidelines governing root resorption did not question the use of CT.^{10,11} CT may be superior to conventional film radiography for assessing root resorption risk associated with

ectopically erupting canines¹⁵ as it has been estimated that 50% more resorption is detected with CT.¹⁶ In the current study, students indicated a higher use of this technology compared with orthodontists. The increased information must be balanced with the increased radiation dose¹⁷ and whether the orthodontic treatment approach would be modified with the additional information.

Classification

The classification and record keeping of the amount of root loss was not standardised. In the present study, millimetre measurements were popular amongst American respondents, whereas Australians preferred the descriptors of mild/moderate/severe. Both methods have been used in the literature.¹⁸ Consistency within individual clinics in order for temporal comparison would be ideal. If a universal approach within the orthodontic profession was agreed, the sharing of data may be made easier for future research in this field.

Risk factors

The most frequently cited perceived risk factor in the present study was a previous history of root resorption which supports previous research observations.¹⁹ Patients at risk of severe resorption may be identified according to the amount of resorption during the initial stages following the commencement of treatment (within the first 6 months).²⁰ Additional risk factors mentioned in the present study were a history of trauma and a family history of root resorption. Previous trauma has been noted to indicate an increased risk; however, there have also been studies in which no evidence of root resorption has been reported following dental trauma.^{5,21}

Genetic studies have supported the observation that a familial history may be an important clinical consideration when evaluating risk of root resorption. Evidence has been found of linkage disequilibrium of IL-1B polymorphism. The IL-1B gene is known to decrease the production of IL-1 cytokine which is associated with an increased risk of root resorption.⁶

Management of root resorption noted during treatment

Most orthodontists surveyed would likely review root resorption, once noted, in three to six months. This is

in agreement with a retrospective study which found most clinicians took radiographs at six months.¹⁰ A modification of the approach to care was indicated if root resorption was discovered during treatment. Lighter forces, periods of rest and reducing treatment time were noted as possible methods of management by all surveyed groups. Teeth moved with lighter forces experienced less and less severe root resorption.⁵ Discontinuous forces have also been shown to be associated with reduced root loss.²² Resting periods (of two to three months²³ and cessation of orthodontics have been prevention methods employed by practitioners to restrict the severity of resorption and these approaches are supported in the literature.¹⁰ Other factors such as bracket type (self-ligating vs conventional and standard edgewise vs straightwire) or techniques (Begg, Tweed, Edgewise, Straightwire one-phase vs two-phase treatment plans) were considered unimportant, which agrees with published evidence.⁵

In the present study, the preferred treatment option for ectopically erupting permanent canines was the removal of their deciduous predecessors. This follows the recommendations of Ericson and Kuroi.^{24,25} Once erupting canines have caused damage to incisors, most participants would commence exposure and orthodontic traction.²⁶

A modification to an extraction treatment option would be considered by surveyed respondents. If extraction treatment was required for orthodontic correction, Australian and American students preferred to compromise and camouflage the malocclusion without extractions. Premolar extraction cases have been found to experience more root resorption during treatment. It has therefore been suggested that consideration be given to avoiding extractions for overjet correction in cases which may require extended treatment time.²⁷

Retention

A fixed wire retainer was the favoured retention method of those surveyed. Relapse could occur due to migration and fixed retention has been suggested if removable retention is inadequate.²⁸ Flexible retention allows limited physiologic movement between teeth; however, movement may contribute to fatigue and subsequent failure of the material.²⁸ A long term review using removable and twist-flex bonded retainers suggested that there were no differences

between groups in relation to mobility.²⁹ Without root resorption considerations, there was still debate regarding a universally ideal and evidence-based approach to orthodontic retention in general.³⁰

A combination of major themes expressed in the survey responses provides a summary of the general approach to orthodontic root resorption: (1) the use of the orthopantomogram as a screening diagnostic tool, followed-up by periapical radiographs for those perceived as 'higher risk' patients, particularly those with a history of root resorption, (2) six-monthly radiographic follow-up during treatment, (3) the use of light forces and/or rest periods (discontinuous forces) every two to three months, (4) the extraction of deciduous teeth if permanent successors were erupting ectopically and causing damage to adjacent roots and (5) the use of fixed retention after treatment. Although the survey indicated that there was no single agreement on a universal approach to aspects of diagnosis and management, there was commonality amongst practitioners, especially those from the same country of clinical practice. Similarity of responses also depended on career experience.

Conclusion

This pilot survey assessed the approach of practising orthodontists, represented by two groups of different professional levels and experience, as to their current diagnostic and clinical approaches to the management of root resorption. The responses demonstrated that there was no single universal approach amongst practitioners. However, there were common themes in responses, the majority of which related to the country of practice and stage of career. Approaches were based on scientific evidence; however the consensus in the literature reflected the various approaches in clinical practice. It is expected that this project will initiate discussion and form a basis for further investigation into the clinical approach for the management of orthodontic root resorption.

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