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# Endodontic-orthodontic interrelationship: a review

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## Abstract

The endodontic-orthodontic interface is not well understood due to the limited scientific literature on the topic. This article aims to provide an overview of the orthodontic treatment and the risk of root resorption, the effects of orthodontic tooth movement on dental pulp and endodontically treated teeth, the role of orthodontics in endodontic-restorative treatment planning, and interdisciplinary patient management. Articles published in English from 1982 to 2021 were searched manually from google scholar using keywords 'endodontic-orthodontic interface' and 'endodontic-orthodontic interrelationship'. Another search engine was MEDLINE/PubMed database using keywords 'endodontics AND orthodontics', 'orthodontic tooth movement AND dental pulp', 'orthodontic tooth movement AND endodontic treatment' and 'orthodontics AND dental trauma'. Other relevant articles were obtained from the references of the selected papers. Alterations to the dental pulp following orthodontic tooth movement can be histologic and/or cell biological reactions as well as the increased response threshold to pulp sensibility tests. However, the occurrence of root resorption is complex and multifactorial, and can be linked to individual variation, genetic predisposition and orthodontic treatment-related factors. Endodontically treated teeth can move as readily and respond similarly to orthodontic forces as vital teeth, however with inadequate endodontic treatment, the risk of apical inflammation and bone destruction following orthodontic tooth movement is increased. Dental treatment that involves endodontic and orthodontic specialities should be carefully planned according to the individual case, taking into consideration the skills and experience of the clinicians while applying interdisciplinary patient management and available scientific data.

***Keywords:*** *endodontic, orthodontic tooth movement, endo-ortho interface, pulpal changes, tooth resorption*

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## Introduction

The endodontic-orthodontic interface is not well understood due to the limited scientific evidence on the topic. To date, there is a lack of uniformity in the study protocols reported in the literature, reflecting the disparities in this subject. Therefore, the interpretation of results should be made with great caution owing to the differences in study methodology and variations in data reporting. Without thorough understanding on the subject, application of general treatment procedure is not possible, and an effective treatment plan is difficult to be executed.

When planning for patient management involving combined treatment modalities, treatment must consider the possible adverse reactions to the patients, skills and experience of the clinicians, patient-related factors and available scientific evidence supporting treatment, although at present the reported data is sparse. In certain clinical cases, the need for orthodontic tooth movement prior to endodontic and/or restorative treatment is necessary to optimise the aesthetics and functional aspects of dental treatment. Adequate communication and planning between the restorative dentist, orthodontist and other clinicians before the implementation of any treatment is crucial so that the duration of time needed to fulfill the treatment objectives and the treatment cost can be discussed thoroughly with patients (Alfallaj, 2020).

Literature search was carried out from google scholar using keywords ‘endodontic-orthodontic interface’ and ‘endodontic-orthodontic interrelationship’. Another search engine was MEDLINE/PubMed database using keywords ‘endodontics AND orthodontics’, ‘orthodontic tooth movement AND dental pulp’, 'orthodontic tooth movement AND endodontic treatment' and 'orthodontics AND dental trauma'. Articles published from 1982 to 2021 were reviewed independently by two evaluators in regard to the scientific contents. The reference lists of the selected articles were reviewed to identify additional studies that had not been identified earlier from the database. In general, 77 published articles were included in this review with lack of original research articles on the topic and the majority of articles are mainly on case reports, narrative reviews and other types of studies (Table 1). Due to the inadequacy in scientific quality, the understanding on the topic is lacking thus could potentially result in misdiagnosis and improper patient management.

## Orthodontic treatment and risk of root resorption

It has been suggested that orthodontic tooth movement can cause neurovascular disturbances, and the release of inflammatory mediators can impair blood flow and cellular metabolism, resulting in apical root remodeling or resorption during tooth movement (Hamilton & Gutmann, 1999). However, the incidence and severity of these changes may be influenced by previous or ongoing insults to the dental pulp such as dental trauma (Hamilton & Gutmann, 1999; Yang *et al.,* 2016).

To date, the mechanism of how orthodontic treatment influences root resorption is not clearly understood. The causative factors are complex and may include individual variation, genetic predisposition and/or orthodontic treatment-related factors (Weltman *et al.,* 2010). Possible aetiologies of root resorption that are associated with orthodontic treatment include; magnitude of applied force, direction of tooth movement, duration of the orthodontic treatment, amount of apical displacement, method of force application (continuous vs intermittent) and/or type of appliance. Meanwhile, patient-related factors include; previous history of dental trauma, existing root resorption, individual susceptibility, and/or genetic predisposition (Lopatiene & Dumbravaite, 2008; Aydin & Er, 2016).

A traumatised tooth can be moved orthodontically with minimal risk of root resorption provided that the dental pulp is not infected. However, if the dental pulp is compromised, appropriate endodontic treatment is essential prior to orthodontic tooth movement (Hamilton & Gutmann, 1999; Yang *et al.,* 2016).

Additionally, when the apical root of the traumatised tooth shows signs of root resorption before orthodontic tooth movement, the possibility of progression of the root resorption during orthodontic treatment is high (Yang et al., 2016).

Table 1. Descriptions of the included studies

| Type of study | Number | Area of studies |
|---|---|---|
| Meta-analysis/ systematic review | 9 | • Orthodontic-induced root resorption.<br>• Influence of orthodontics on dental pulp. |
| Prospective study | 7 | • Influence of orthodontics on dental pulp.<br>• Influence of orthodontics on vitality of dental pulp in teeth with a previous history of dental trauma. |
| Retrospective study | 4 | • Influence of orthodontics and quality of endodontic treatment on periapical inflammation.<br>• Roles of orthodontics prior to implant placement.<br>• Influence of orthodontics on apical root resorption in endodontically treated teeth and vital teeth.<br>• Influence of orthodontics on dental pulp. |
| Laboratory study including animal study | 12 | • Molecular markers of dental pulp tissue, microvasculature of dental pulp and other histological changes following orthodontics. |
| Case report/series | 24 | • Interdisciplinary patient management.<br>• Dental pulp responses during orthodontics.<br>• Roles of orthodontics prior to implant placement. |
| Cross-sectional/survey | 2 | • Treatment plans of traumatised teeth. |
| Review article | 19 | • Roles of orthodontics in restorative treatment planning or prior to implant placement.<br>• Effects of orthodontics on dental pulp, dental hard tissues, and periapical region.<br>• Interdisciplinary patient management.<br>• Relative merits of case reports.<br>• Influence of dental trauma on the management of orthodontic treatment. |

Even though this was highlighted in the systematic review, it should be carefully interpreted owing to the methodological variations in the included studies such as number of subjects, age differences, duration of orthodontic treatment, standardisation of pre-treatment and post-treatment radiographs, study method of external root resorption and type of teeth included for analysis (Yang *et al.,* 2016)

In a survey conducted recently, dental practitioners (general dentists, paediatric dentists and orthodontic specialists) were tested for their knowledge on the possible complications of traumatised teeth that are moved orthodontically and the researchers found that there were varying levels of knowledge on the topic (Van Gorp *et al.,* 2020). Orthodontic specialists were more confident in providing orthodontic treatment to the traumatised teeth because the history of dental trauma were not considered as an absolute contraindication, rather than an aspect that is premeditated since the treatment planning stage (Van Gorp *et al.,* 2020). The skills and experience of the orthodontic specialists could possibly lead to this decision, not only they focus on the active orthodontic treatment but also periodic follow-up of the traumatised teeth. When the signs and symptoms of root resorption are evident, early intervention can be undertaken to minimise the progression.

## Effects of orthodontic treatment on dental pulp

Orthodontic tooth movement can cause biological reactions in human dental pulp and periodontal ligament. The reactions include; neurovascular disturbances, trigger of inflammatory responses, degenerative changes, increased neural activity and/or altered sensation (von Böhl *et al.,* 2012; Gulabivala & Naini, 2014; Aydin & Er, 2016; Yang *et al.,* 2016) as well as reduced pulpal blood flow, when measured using Laser Doppler flowmetry (Ersahan & Sabuncuoglu, 2018). Besides causing biological changes, molecular changes have also been reported including reduced alkaline phosphatase (ALP) activity, increased aspartate aminotransferase (AST) activity, increased number and diameter of microvessels, release of angiogenic and vascular endothelial growth factors (von Böhl *et al.,* 2012), altered gene expression (Abdul Wahab *et al.,* 2012), as well as expression of neurotransmitters (Chavarría-Bolaños *et al.,* 2014) and inflammatory mediators (Yamaguchi *et al.,* 2004). The expression of neuropeptides such as substance P and calcitonin gene-related peptide indicate the role of neurotransmitters in early pulpal inflammation response (Chavarría-Bolaños *et al.,* 2014), could be attributed to the stimulation of inflammatory mediators (interleukin-1β, interleukin-6, and tumour necrosis factor-α) in the dental pulp (Yamaguchi *et al.,* 2004). Furthermore, gene expression analysis via GeneFishing technique indicates the presence of specific genes that has potential as biomarkers to monitor the progression of orthodontic treatment (Abdul Wahab *et al.,* 2012).

Physiological changes in the dental pulp interfere with neural activity by increasing the response thresholds to electrical stimulus (Veberiene *et al.,* 2010; Alomari *et al.,* 2011; Modaresi *et al.,* 2015). A previous study reported lower response thresholds after 1-month application of orthodontic force, but values remained higher than the baseline records (Modaresi *et al.,* 2015). However, this report contradicted results from another study whereby the authors observed an increased response thresholds after 1-month application of orthodontic force (Hall & Freer, 1998). Increased response thresholds occur as a result of compression or tension on the apical nerve fibers, resulting in a compromised response to the electric pulp test (Modaresi *et al.,* 2015). Threshold values depend on the degree and the duration of the application of orthodontic forces (Briseño-Marroquín *et al.,* 2021). This situation should be taken into consideration when assessing the status of dental pulp in patients undergoing orthodontic treatment (Modaresi *et al.,* 2015). The dental pulp should not be regarded as non-vital without apparent clinical signs and symptoms such as spontaneous pain, swelling, pain to percussion and/or palpation, pus discharged through sinus tract and periapical radiolucency. Changes in physiology of the dental pulp is caused by various factors including orthodontic treatment related factors, maturity of the apical root and/or age of patients (Gulabivala & Naini, 2014). Teeth with immature root apices are less likely to be affected due to a richer, thicker and larger supply of neurovascular bundle to the tooth (Gulabivala & Naini, 2014; Aydin & Er, 2016).

The application of appropriate or light orthodontic force enables sufficient tooth movement, limits the damage in the dental pulp and allows for the repair of any damage that is developed during orthodontic treatment (Aydin & Er, 2016). This was demonstrated in a recent in vivo study involving human dental pulp where no irreversible iatrogenic changes were observed in the dental pulp following application of appropriate orthodontic forces for tooth movement (Vermiglio *et al.,* 2020). Orthodontic tooth movement is not a direct cause of pulpal necrosis (Consolaro & Consolaro, 2018; Weissheimer *et al.,* 2021) and obliteration of the dental pulp, but when these are observed following orthodontic tooth movement, a previous history of dental trauma could possibly be the aetiological factor (Javed *et al.,* 2015; Yang *et al.,* 2016; Consolaro & Consolaro, 2018). This might explain a higher frequency of pulpal necrosis in teeth with severe periodontal tissue injuries that underwent orthodontic treatment, mainly was attributable to the previous history of dental trauma ( Bauss *et al.,* 2008; Bauss *et al.,* 2010). The frequency of pulpal necrosis in traumatised teeth was reported to be 9.1% (Bauss *et al.,* 2010) and 10.4% (Bauss *et al.,* 2008) compared to 0.3% (Bauss *et al.,* 2008) and 0.5% (Bauss *et al.,* 2010) in teeth without dental trauma.

In animal studies, changes in dental pulp tissue following orthodontic-induced tooth movement are limited to hemodynamic (microvasculature) aspects with no irreversible degeneration of the dental pulp (Grünheid *et al.,* 2007; Abi-Ramia *et al.,* 2010; Cuoghi *et al.,* 2018). This could be due to the increased expression of inflammatory mediators (interleukin-1β, and tumour necrosis factor-α) in dental pulp tissue (Bletsa *et al.,* 2006). Often the changes are temporary, has an excellent capacity for adaptation (Santamaria Jr *et al.,* 2006) and are able to return to normal healthy status when the stimulus is halted (Santamaria Jr *et al.,* 2007). In teeth subjected to orthodontic force, higher vascular volume density was observed in the coronal dental pulp compared to the teeth not subjected to orthodontic force (Santamaria Jr *et al.,* 2006). Vascular volume density at 6 hours, was high but fell after 24 and 72 hours, almost similar to the values in the dental pulp not subjected to orthodontic force (Santamaria Jr *et al.,* 2006). The findings observed in the experimental rats were also mirrored in human cell experiments using haematoxylin-eosin staining (Lazzaretti *et al.,* 2014) and/or immunofluorescence (Vermiglio *et al.,* 2020) analyses. In a clinical study, orthodontic force was applied to the teeth of younger and older subjects via fixed orthodontic appliance, and pulpal blood flow was measured using Laser Doppler flowmetry. The results showed initial reduction in the pulpal blood flow values in both subjects (Ersahan & Sabuncuoglu, 2018). Even though a recovery process followed after completion of the experiment, pulpal blood flow values in the latter remained low and did not return to the baseline levels (Ersahan & Sabuncuoglu, 2018). The authors concluded that, the ability of dental pulp to return to its initial state may depend on the age of the patients. However, this needs to be interpreted with caution as the subject samples were small and the duration of observation was only one month. To date, studies on the effects of longer periods of orthodontic tooth movement in older subjects has not been conducted, therefore the reversible nature of changes in pulpal blood flow remain unclear.

## Effects of orthodontic treatment on endodontically treated teeth

In dental practice, there is often the need to move teeth whether the teeth are vital, have been endodontically treated or undergoing endodontic treatment (Aydin & Er, 2016). Orthodontic movement of endodontically treated teeth was not commonly practiced for many years and clinicians tend to avoid applying orthodontic forces to these teeth because of the general belief that orthodontic tooth movement increases the risk of root resorption (Aydin & Er, 2016). However, improved understanding of treatment outcomes and techniques, supported by the scientific data in current practice has increased clinicians' confidence to provide such treatment. The clinical importance of pulpal alterations after orthodontic treatment depends on whether or not it will endanger long-term vitality of the teeth (von Böhl *et al.,* 2012; Gulabivala & Naini, 2014; Aydin & Er, 2016).

There is controversy in the literature concerning the risk of root resorption in endodontically treated teeth because of the susceptibility to root resorption (Aydin & Er, 2016). However, endodontically treated teeth without signs of root resorption can be moved orthodontically without extensive root resorption (Malmgren & Malmgren, 2007) provided that the endodontic treatment procedures are effective with no coronal leakage and allow no access for bacterial invasion (Walker *et al.,* 2013; Aydin & Er, 2016; Yang *et al.,* 2016; Esteves *et al.,* 2007). This might clarify the reported data in a meta-analysis (Alhadainy *et al.,* 2019) and two systematic reviews (Walker *et al.,* 2013; Yang *et al.,* 2016) that showed no statistically significant differences in the amount and severity of root resorption between endodontically treated teeth and vital teeth when equal amounts of orthodontic force is applied, and a high success rate of tooth retained in the occlusion was also observed (Medeiros & Mucha, 2009).

There is limited data in the literature reporting orthodontic tooth movement in teeth with apical lesions or apical periodontitis following root canal treatment, and in teeth with a history of periradicular surgery (Hamilton & Gutmann, 1999; Walker *et al.,* 2013; Aydin & Er, 2016; Yang *et al.,* 2016). It is also unclear pertaining to the ability of teeth that have undergone periradicular surgery to move successfully following orthodontic treatment. The reported data on the combined treatment modalities of periradicular surgery and orthodontics was published by limited numbers of researchers (Pedullà *et al.,* 2015; Singh *et al.,* 2018; Bi *et al.,* 2020). In a case report with interdisciplinary patient management, the orthodontic-surgical extrusion of the impacted maxillary canine and periaradicular surgery of the deviated root of an adjacent premolar showed successful treatment outcomes (Pedullà *et al.,* 2015). Periradicular surgery to remove the dilacerated root of the right maxillary incisor that performed after orthodontic traction resulted in successful outcomes; having good periodontal and orthodontic stability (Singh *et al.,* 2018). Another case reporting a combination of orthodontic tooth movement and periradicular surgery resulted in a resolution of periapical inflammation and no progression of root resorption after a two-year follow-up (Bi *et al.,* 2020). Although case reports could provide some guidance to the clinicians, the interpretation of the results must be carefully made due to the limitations including publication and recall biases, does not represent the population hence the findings could not be generalised (Nissen & Wynn 2014).

Regarding the regenerative endodontic procedures and orthodontic tooth movement, although there is limited scientific evidence, the outcomes have been highlighted in the previous case reports (Al-Tammami & Al-Nazhan, 2017; Chaniotis, 2018; Natera & Mukherjee, 2018). It is an essential prerequisite to provide an effective endodontic treatment for successful orthodontic tooth movement (Hamilton & Gutmann, 1999; Walker *et al.,* 2013; Aydin & Er, 2016; Yang *et al.,* 2016) because the risk of apical lesions and bone destruction following orthodontic tooth movement was significantly increased in endodontically treated teeth with inadequate endodontic treatment (Alqerban *et al.,* 2019). This might explain the absence of statistically significant differences in the incidence of root resorption between endodontically treated teeth and vital teeth as highlighted in the previous studies (Walker *et al.,* 2013; Yang *et al.,* 2016; Alhadainy *et al.,* 2019).

## Role of orthodontics in endodontic-restorative treatment planning

Orthodontic treatment could recreate a space for future prosthetic restoration such as dental bridge or dental implant (Chalala, 2012). It could aid in tooth alignment by distributing the space in the arch adequately, thus the clinicians could plan for the restorative treatment effectively, for instance in hypodontia cases. Another aspect that is advantageous is that, the orthodontic extrusion of a severely compromised tooth followed by restorative treatment was useful in patient who had a medical history of bisphosphonate and irradiation treatments to avoid the occurrence of medication-related osteonecrosis of the jaw or osteoradionecrosis (Morita *et al.,* 2017).

In dental trauma, crown-root fractures account for 5% of all injuries and the successful management are compromised by a fracture below the gingival margin and/or bone (Sharma *et al.,* 2011). Complicated crown-root fractures are considered challenging because 46% of general dentists find themselves unable to treat the cases and require referral to orthodontic and periodontal specialists (De Castro *et al.,* 2010). In certain clinical cases, orthodontic tooth movement is a feasible approach to align the affected tooth/teeth prior to endodontic treatment as highlighted in the previous case reports (Singh *et al.,* 2018; Bi *et al.,* 2020; Sonoda *et al.,* 2018). Leaving dental pulp untreated after severe dental trauma can lead to complications such as pulp necrosis, apical periodontitis, and root resorption (Scholtes *et al.,* 2018). This could possibly explain the reason of providing endodontic treatment on the affected tooth/teeth before orthodontic extrusion, and the restorative treatment were carried out when the tooth/teeth were successfully repositioned in the arch (Kocadereli *et al.,* 1998; Casaponsa *et al.,* 2020). However, there was reported case in which the initial endodontic procedure and temporary intracanal dressing were carried out prior to orthodontic extrusion, then the endodontic procedure and restorative treatment were performed later when the tooth were extruded to the desired position in the arch (Agarwal *et al.,* 2020).

Patient with inadequate restorative margin may require crown lengthening, which can be achieved either surgically or orthodontically. When comparing two techniques, the latter provides a more favorable crown to root ratio, eliminates the risk of compromising the alveolar bone support of the adjacent teeth, and does not compromise the aesthetics of affected tooth/teeth (Potashnick & Rosenberg, 1982). Various extrusion techniques are available, depending on the clinical conditions encountered and both fixed and removable orthodontic appliances can be used to achieve orthodontic extrusion (Chole *et al.,* 2016). The primary objective of orthodontic extrusion in trauma patients is to provide a sound tissue margin for ultimate restoration and to create a periodontal environment that will be easy to maintain (Calasans-Maia *et al.,* 2003). The amount of force necessary to slowly extrude a tooth depends on the amount of bone on the tooth to be extruded. Orthodontic brackets are placed on the tooth to be extruded and the adjacent teeth sufficient to control the extrusive movement, with no movement of the teeth used for anchorage (Brindis & Block, 2009). When deciding on orthodontic extrusion and restoration with prosthetic rehabilitation, some confounding factors must be considered, such as crown-root ratio, root abnormities, fracture type and location, interocclusal space, and risk of exposure of furcation of a multi-rooted tooth (Bach *et al.,* 2004; Dede *et al.,* 2017). The major limitation of this approach is that it increases the duration of treatment and requires a longer retention period (Kocadereli *et al.,* 1998).

Orthodontics can also be beneficial prior to implant surgery because this approach could preserve the alveolar bone for future implant placement and/or prosthetic restoration (Medeiros & Mucha, 2009), and is a useful alternative to conventional surgical augmentative procedures (Chalala,

2012) because the alveolar bone is advanced coronally to improve vertical bone height at the future implant site (Ovaydi-Mandel *et al.,* 2013; de Avila *et al.,* 2014). During the implant site development procedure, alveolus preservation is a procedure to prepare and maintain an adequate bone volume for implant placement and stabilisation (Irinakis, 2006). After a tooth is extracted, the alveolar bone and soft tissues remodel with a resulting reduction in the horizontal and vertical dimensions of the future implant site (Schropp *et al.,* 2003; de Molon *et al.,* 2013). Bone defects can be treated by different surgical procedures, such as guided bone regeneration and bone grafts depending on the characteristics of the defect itself. Several techniques are available today by using resorbable and non-resorbable devices. These are invasive techniques with a high degree of morbidity and a risk of failure (Conserva *et al.,* 2020). The immediate implant procedure in the aesthetic zone is to furnish a peri-implant tissue architecture that facilitates the establishment of close-to-nature functional and esthetic outcomes. Orthodontic extrusion is also considered as one of the proposed approaches for pre-implant procedures. (Alsahhaf & Att, 2016). Orthodontic forces used during extrusion ranged from 15 g to >80 g; the lowest values are normally used for the anterior teeth or single-rooted teeth, whereas the highest values were for posterior teeth (Conserva *et al.,* 2020). On the other hand, the extrusion speed (mm/month) found was between 0 and 2 mm per month (Conserva *et al.,* 2020). After the tooth has been extruded, it should be stabilised for 6 to 12 weeks to allow for tooth stabilisation and bone consolidation. Overcorrection is also recommended to compensate for the possible loss of bone and gingiva that may occur because of the implant placement surgical procedure. Using orthodontic extrusion for implant site development often involves prior root canal treatment and vertical crown height reduction of the tooth that are to be extruded, to eliminate creating a traumatic bite (Kim *et al.,* 2011; Rasner, 2011). It is important to keep in mind the importance of planning before attempting to extract any tooth. Once the tooth has been removed, the ability to use nature's capacity to grow soft tissue and bone through tooth eruption no longer exist (Brindis & Block, 2009). Teeth that are hopeless and planned for extraction can still be used for physiologic benefit to impart orthodontic augmentation, or site development (Celenza, 2012). Another important role of orthodontic tooth movement is to correct the angulation of teeth adjacent to a potential implant site (Malmgren & Malmgren, 2007; Addy *et al.,* 2009; Gulabivala & Naini, 2014).

## Interdisciplinary patient management

Performing root canal treatment during orthodontic treatment poses a number of difficulties such as pulpal/periaradicular pain that is counfounded by discomfort due to tooth movement, the clinicians face challenges of achieving effective tooth isolation for endodontic treatment procedure, presence of apical root resorption might compromise the determination of working length, the dilemma of whether to complete endodontic treatment during orthodontic or after completion of orthodontic treatment, and presence of carious lesion and/or defective restoration that require effective restoration (Gulabivala & Naini, 2014). There are limited number of studies reporting the appropriate timing for orthodontic treatment following the completion of endodontic procedure. In a case report, the orthodontic treatment was provided after 10 months follow-up when there was an evident of periapical healing (Er *et al.,* 2011). In another case report, the orthodontic treatment was started after 42 months follow-up when the size of abscess had decreased (Chaniotis, 2018). The approach was clearly different when starting orthodontic treatment involving the traumatised teeth as orthodontic extrusion was initiated one week after the endodontic procedure (Mittal *et al.,* 2013; Choudhary *et al.,* 2017). The difference in the time frame could be due to the absence of periapical lesion on the traumatised teeth and aesthetic region that requires restoration (Mittal *et al.,* 2013; Choudhary *et al.,* 2017). However, the observation periods following endodontic treatment prior to orthodontic tooth movement vary based on individual case, ranged from immediate commencement of orthodontic tooth movement to approximately 6-12 months depending on the healing status of periapical inflammation (Kindelan *et al.,* 2008).

Some important aspects to consider during clinical management of teeth requiring integrated endodontic and orthodontic treatment includes the effects of orthodontic tooth movement on the dental pulp and potential root resorption (Hamilton & Gutmann, 1999). Interdisciplinary patient management has been documented in previous case reports with evidence of success such as better aesthetics, asymptomatic, improved function and no evidence of periapical pathology (Mittal *et al.,* 2013; Pedullà *et al.,* 2015; Choudhary *et al.,* 2017; Al-Tammami & Al-Nazhan, 2017; Chaniotis, 2018; Natera & Mukherjee, 2018; Singh *et al.,* 2018; Sonoda *et al.,* 2018; Agarwal *et al.,* 2020; Bi *et al.,* 2020). This includes in special need patients with previous history of dental trauma (Chaushu *et al.,* 2004). The success rate of orthodontic extrusion of traumatised teeth was reported to be 95.45% and only 4.54% teeth failed due to rapid progression of root resorption (Medeiros & Mucha, 2009). The majority of traumatised teeth underwent endodontic treatment due to pulpal involvement and a small number of teeth did not require endodontic treatment due to a vital pulp (Medeiros & Mucha, 2009). Treatment plans that involve various dental specialties must be based on a realistic evaluation of the orthodontic treatment options and optimal treatment procedures to achieve the desired outcomes (Malmgren & Malmgren, 2007).

Nevertheless, the orthodontic treatment is not without endodontic complications, particularly when it is related to the use of temporary anchorage devices (miniscrews) that are placed in the maxillary bone in close proximity to the roots and can result in pulpal necrosis and/or apical periodontitis (Rossi-Fedele *et al.,* 2020). This situation is reported in the previous study where a combination of non-surgical and surgical endodontic procedures were carried out to treat the endodontic complications (Lim *et al.,* 2013). In another study, a non-surgical endodontic procedure was successful in treating the endodontic complications due to placement of minicrews (Er *et al.,* 2011). Meticulous treatment planning involving endodontic and orthodontic aspects may prevent similar cases from repeating, minimising the need for future complex treatment procedures to correct the iatrogenic damages. In addition to this, interdisciplinary approach could improve overall treatment outcomes (Pedullà *et al.,* 2015; Al-Tammami & Al-Nazhan, 2017; Chaniotis, 2018; Natera & Mukherjee, 2018; Singh *et al.,* 2018; Bi *et al.,* 2020) as well as the quality of life of the patient (Singh *et al.,* 2018). Therefore, it is essential that treatment is planned on a case-by-case basis, taking into consideration several factors including the risks and benefits of treatment, patient factors as well as the experience of clinicians in conducting complex and lengthy treatment procedures.

## Conclusion

Dental treatment that involves endodontic and orthodontic specialities should be carefully planned according to the individual case, skills and experience of the clinicians, incorporating integrated patient management with guidance from available scientific evidence. Sound knowledge and thorough understanding of the endodontic-orthodontic interface could help clinicians to provide effective treatment and eventually improve the outcomes and patient well-being.

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