

IATROGENIC IN ORTHODONTICS – PART II

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ABSTRACT

The goal of this research was to investigate iatrogenic effects of orthodontic therapy through a systematic literature review. The systematic literature search was performed through computer research of several databases (Google Scholar, PubMed, ResearchGate, Scielo, SpringerLink, NCBI, American Dental Association ADA). 28 articles were included in the review. Iatrogenic effects of orthodontic treatment can be classified into two groups: local and systemic.

Introduction

Before starting every orthodontic treatment, as a long-term and complex procedure, it is very important to determine the correct therapy plan for each patient. It is important to take into account the risks that can be associated with the patient and thus ensure the success of the therapy. For the treatment to be considered successful the benefits offered by the treatment must outweigh any possible harm it may cause (1). Even though orthodontic therapy offers many benefits, still there is a possibility of side effects if certain oversights are made during the treatment. Side effects or disease caused by a dental treatment or by an oversight on the part of the therapist in the process of patient treatment is called iatrogenic effect or iatrogenic disease (2). Several factors are cited as the reason for their occurrence, among which these are the most common: orthodontist's clinical skill, application of orthodontic force, selection of an orthodontic appliance, orthodontic treatment procedures, length of therapy, but also the influence of the patients themselves (1). The orthodontist should control the entire course of the therapy, be aware of the risks and take appropriate steps to prevent complications. It is unacceptable to place an orthodontic appliance in the case of poor oral hygiene, dental plaque, periodontal disease or caries. Orthodontists' cooperation with doctors of other dental specialties, and above all with the patient, has a significant effect on achieving therapeutic success (3). Characteristics related to the patient that can influence the occurrence of side effects of orthodontic treatment refer to the patient's age, patient's sex, the environment in which the patient lives, genetic predisposition, psychological type of the patient, pathophysiological status, as well as the characteristics related to malocclusion (type, etiology, the severity of the case) and the existence of craniofacial anomalies (4). To reduce their effect and achieve the desired results it is important to process each case separately and plan treatment and conduct therapy based on that.

This research aims to explore which iatrogenic effects of orthodontic treatment there are through a systematic orthodontic review of the literature.

Materials and methods

Through computer research of several databases (Google Scholar, PubMed, ResearchGate, Scielo, SpringerLink, NCBI, American Dental Association ADA), we have found and analyzed various articles used in this research. Different combinations of keywords were used when searching the database: iatrogenic effects, risk factors and orthodontic treatment.

Inclusion criteria included papers in English language, available in their entirety.

A limitation of this search was that only articles that were fully available to the authors were used.

Results

185 articles were found searching various databases.

Within this literature review, 28 articles that met the given criteria were analyzed.

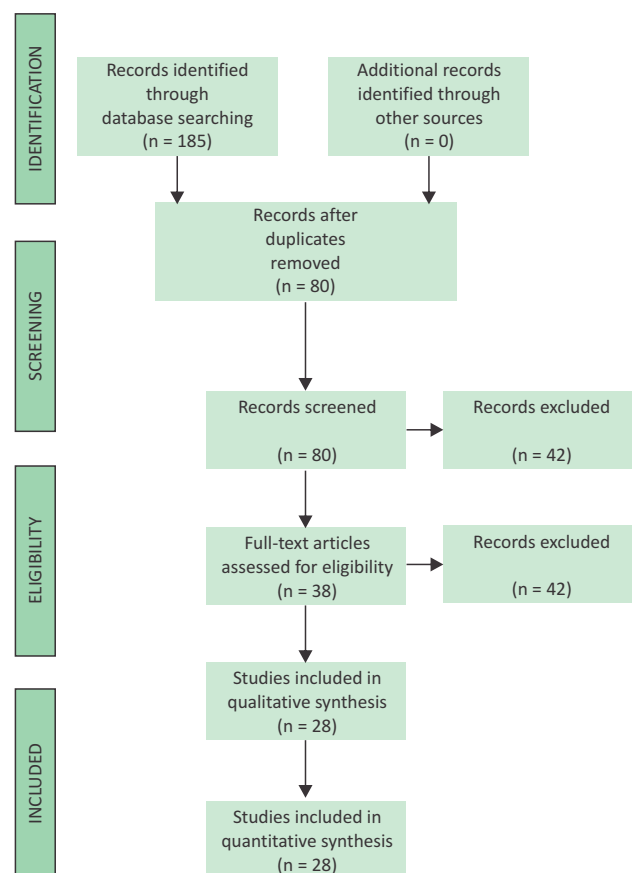


Figure 1. The flow of records through the reviewing process

Discussion

Side effects associated with the orthodontic therapy itself are significantly lower than compared to other surgical and non-surgical interventions, but that does not mean that they should be ignored.

One of the challenges for most orthodontists is to complete the orthodontic therapy with the least possible effects on teeth and periodontium. Orthodontic therapy is usually contraindicated in patients with active periodontal disease or poor periodontal health because in this case, the chance for further deterioration of the condition becomes greater. Therefore, before starting orthodontic therapy, a thorough assessment of periodontal health and gingival level is recommended. It is especially important to emphasize the need to maintain good oral hygiene to achieve satisfactory results. Generally, the benefits of orthodontic therapy must outweigh any potential harm. The patient, as the main participant in making decisions about the treatment, has a right to be informed about the benefits and possible risks that may arise during and after the treatment (5).

Enamel damage during orthodontic treatment

Therapeutic procedures performed during orthodontic therapy can cause irreversible physical damage even to the deeper parts of the enamel (6). Phases of therapy associated with potential enamel damage include cleaning with abrasive agents before applying the acid, acid etching, removal of brackets, mechanical removal of composite residue with rotary instruments or brackets re-bonding (7). Additional enamel loss can occur as a result of intentional enamel reduction in cases when space is needed to straighten the teeth with high density or it is necessary to correct deviations in teeth size (8). One of the frequent complications that can occur during orthodontic treatment also includes demineralization of enamel and the formation of white spot lesions due to the accumulation of plaque on fixed orthodontic appliances, together with enamel discoloration or enamel abrasion due to the contact with brackets of antagonist tooth (9). Enamel damage during bracket placement is most often associated with the action of phosphoric acid.

The effect of phosphoric acid etching involves the dissolution of enamel hydroxylapatite crystals leading to the demineralization of the surface layer of the enamel and exposure of the dentine collagen network. Phosphoric acid causes selective dissolution of the cores or boundaries of enamel prism and the formation of microporosity, with variations in depth from 10 to 80 μm (9). This creates a porous surface prone to retaining colored stains, although the porous surfaces are filled with precipitates over time (10). To control excessive enamel loss, maleic and polyacrylic acids were used as alternatives to phosphoric acid, but have resulted in weaker bond strength (11). Adhesive removal after bracket removal can lead to the loss of 14.3- 160 μm of enamel surface depending on the method used. The need to find an efficient and safe adhesive removal method after removing the brackets has resulted in the introduction of a wide range of instruments and procedures, including manual removal with scalers or pliers, the use of tungsten carbide burs with a configuration of 8 to 32 of low or high speed, Sof-Lex discs, special composite finishing systems with zirconium paste, as well as the application of ultrasound and laser (9).

Carious lesions associated with orthodontic treatment

Demineralization of the enamel surface or white spot is one of the main side effects of fixed orthodontic therapy with appliances, despite the progress of technology and materials in preventive dentistry and orthodontics. They appear during the treatment and sometimes persist even after it which can jeopardize the outcome of the treatment and result in early termination of the treatment (12). The presence of plaque retention sites in patients with malocclusion, and additionally placing fixed orthodontic appliances on the teeth, creates additional retention sites in those patients even on surfaces that are mostly not susceptible to caries. Oral hygiene is, therefore, harder to carry out indicating a much stronger connection between oral hygiene and caries frequency in orthodontic patients than in non-orthodontic patients (13). The presence of white spots is significantly higher in orthodontic patients than in those who were not treated with orthodontic appliances, and they can represent an

aesthetic problem years after the treatment. The literature review has shown that overall incidence varies widely between 2% and 96%, with the fact that the prevalence of white spots on at least one tooth was found to be 49.6% in patients who underwent orthodontic treatment compared to 24% in the control group of untreated patients (14). Generally, the prevalence of "white spots" in patients after orthodontic treatment varies from 15% to 85%, and most of the studies report 50% to 70% (15). Any tooth in the mouth can be affected, but most often those are molars, maxillary lateral incisors and canines, as well as mandibular premolars (14). Numerous studies have shown that the biggest responsibility for "white spots" lies with the patient. On the other hand, dentists and orthodontists play an important role in identifying high-risk patients guiding them toward an appropriate preventive regimen (16,17).

The effect of orthodontic treatment on the pulp

The force applied to the periodontium can cause mechanical damage and lead to inflammation of the pulp-dentine complex. Even though orthodontic tooth movement is relatively safe for pulp health, certain situations can lead to pulp necrosis. This usually happens in teeth with previously compromised pulp, e.g. teeth that suffered trauma, teeth with extensive restorations, etc (18). By applying orthodontic forces to the teeth molecular changes within the cells of the periodontium occur. The peripheral sensory nervous system contributes to the development of acute and chronic inflammatory processes through the local release of neuropeptides. However, there is still no accurate evidence of the relationship between orthodontic forces and pulp tissue in humans (19). Proffit et al claim that continuous mild force affects the PDL but has little or no effect on the pulp (20). Some authors believe that excessive intrusive/extrusive force can disrupt the circulation of the dental pulp and degenerate the odontoblastic layer (21). These factors potentially result in pulp necrosis. In their research, Wang et al find that the prevalence of tooth pulp damage in adolescence, which is a result of orthodontic treatment, was around 2%-17% for canal obliteration and 1%-14% for pulp necrosis (18). Although there are very few reports on the loss

of tooth vitality due to excessive orthodontic force, it is still assumed that the application of higher orthodontic force can potentially cause changes in the pulp and the consequences are much more severe (18).

Temporomandibular dysfunction

There is a hypothesis that different orthodontic procedures (e.g. functional appliances, elastic tractions class II and III, chin cap, headgear, fixed or mobile appliances), and therapy plans can be considered etiological factors of temporomandibular dysfunctions (TMD) (22), and Henrikson and Nilner (23) have conducted research to compare the state and function of the joint in orthodontically treated and untreated patients with malocclusion II/1, aged 11 to 15, comparing both groups with patients having proper occlusion. All those patients were treated with a fixed appliance using a headgear or class II elastic tractions, or with extractions. Signs and symptoms of TMD were monitored for 2 years. Individual fluctuations of TMD symptoms have been reported in all three groups. In orthodontic group, the prevalence of TMD symptoms has been reducing during the two years period. The Class II group and normal occlusion group have shown less change during the two years. Clicking at the temporomandibular joint increased in all three groups over the two years. Therefore, orthodontic treatment did not increase the risk or worsen the signs of TMD from before the treatment. On the other hand, subjects with class II malocclusion and TMD signs of muscular origin appeared to have a functional benefit from the orthodontic treatment in the two-year perspective (23). Rey et al (24) compared class III patients treated with orthodontic cervical headgear, class I patients treated orthodontically without extractions and subjects that have not been previously treated for the presence or absence of TMD. Class III patients treated with cervical headgear and a fixed appliance for 2-3 years did not have a higher prevalence of TMD signs and symptoms than class I patients that were only treated with fixed appliances or were not treated at all. Therefore, modifications in the temporomandibular joint caused by treatment must be interpreted as changes in remodeling (24). Another topic of debate among orthodontists is, also,

the influence of orthognathic surgery on TMD. Some reports suggest that operation can relieve the signs and symptoms of TMD (25) while others indicate that surgery could initiate or worsen temporomandibular dysfunction (26). Scientific evidence was insufficient to evaluate the effects that orthognathic surgery had on TMD. According to current findings, the role of orthodontic treatment in the development of TMD has not been confirmed. Accordingly, a meta-analysis on the effects of orthodontic therapy on TMD reported that no study found that traditional orthodontic treatment, including appliances, class II elastic traction, bionator and headgear, face mask and chin cap, increased the prevalence of TMD (27). Although most of the studies consistently do not support the relation between orthodontic treatment and temporomandibular dysfunctions, it must be emphasized that definitive conclusions cannot be drawn due to the unknown causes of TMD, heterogeneity in methodology and study design and the lack of widely accepted classification schemes (22).

Accidentally ingested parts of the orthodontic appliance

Accidental ingestion of orthodontic appliance parts, although very rare, is a potential hazard that should not be taken as granted and all possible measures must be taken to prevent its occurrence. In practice, cases of ingesting the appliance and retainer wire are most often cited. Not only smaller components such as brackets, rings and tubes are swallowed, but even relatively larger devices such as quad helix and palatal expander. The palatal expander activation key is another component that can be accidentally swallowed (28). According to the above, procedures and measures can be found in literature to prevent this not-so-common, but still possible, orthodontic iatrogeny (2).

All orthodontic offices should take into account the possibility of such situations occurring and should be well-prepared to deal with any unforeseen circumstances. Every orthodontist must know how to provide first aid to a patient. Updating and improving these skills is recommended at least once every 2 years, as cardiopulmonary resuscitation (CPR) recommendations are updated every 5 years (2).

Conclusion

Orthodontic treatment offers numerous advantages, but there is still the possibility of unwanted effects. Iatrogenic consequences of orthodontic treatment can be classified into two groups: local and systemic. Fortunately, more serious damage is a rare occurrence. Before starting orthodontic treatment both the patient and the orthodontist should consider the benefits and the risks of the proposed treatment. Correct diagnosis, detailed therapy plan, regular check-ups and timely intervention, as well as good cooperation between the patient and the orthodontist, are the key to the success of any orthodontic therapy. Most of the harmful effects of orthodontic treatment can be avoided by taking certain precautions during the treatment. The orthodontist is obliged to familiarize the patient with all possible harmful effects of orthodontic therapy.

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