

IATROGENIC IN ORTHODONTICS – PART I

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ABSTRACT

The aim of this research was to determine the iatrogenic consequences of orthodontic therapy. This review paper encompasses literature from the following databases: Google Scholar, PubMed, ResearchGate, Scielo, SpringerLink, NCBI, and American Dental Association (ADA). The search was conducted using combined text and MeSH search strategies using keywords in different combinations. 34 articles that met the given criteria were analyzed within this literature review. Iatrogenic effects of orthodontic treatment can be classified into two groups: local and systemic.

Introduction

Orthodontics is a branch of dentistry dealing with monitoring, guiding and correcting of growth and development of dentofacial structures (1). Treatment using orthodontic appliances represents a great challenge for every therapist because it requires a lot of patience and work commitment, but also taking a series of measures to be completed. For the treatment to be considered successful, the benefits offered by the treatment must prevail any possible harm it may cause (2). Undesirable effects or diseases caused by dental treatment, or an omission by the therapist in the process of treating the patient, is called an iatrogenic effect or iatrogenic disease (3). Iatrogenic in orthodontics can be described as situations leading to reversible or irreversible damage in patients undergoing any type of orthodontic treatment (4). Many factors are cited as a reason for their occurrence, among which are the most common: orthodontist's clinical skill, application of orthodontic force, selection of orthodontic appliance, orthodontic procedures of treatment, length of treatments as well as the influence of patients themselves (2). According to numerous authors, many conditions can be linked to orthodontic treatment. Even if, for most, there is no evidence of a direct causal relationship, they must be seriously considered and patients must be informed about them (5).

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

Materials and methods

This review paper encompasses literature from the following databases: Google Scholar, PubMed, ResearchGate, Scielo, SpringerLink, NCBI, and American Dental Association (ADA). The search was conducted using combined text and MeSH search strategies using keywords in different combinations: iatrogenic effects, risk factors and orthodontic treatment. Inclusion criteria imply papers in English language available in their entirety. 34 articles that met the given criteria were analysed within this literature review.

Results

185 articles were found by searching various databases.

34 articles that met the given criteria were analysed within this literature review.

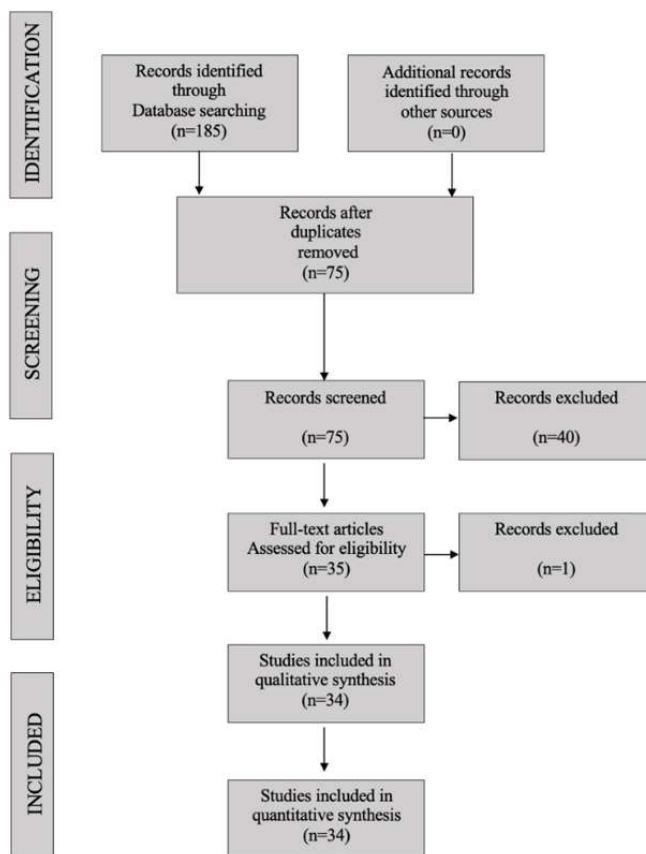


Figure 1.

The flow of records through the reviewing process

Discussion

Like any other medical intervention, aside from the advantage offered by orthodontic treatment, there are also disadvantages and certain risks to which the patient may be exposed. Harmful effects of orthodontic treatment can be local, that is intraoral and extraoral, and systemic (6).

One of the challenges for most orthodontists is to complete the orthodontic treatment with the least harmful effects on the teeth and the periodontium. Orthodontic treatment is usually contraindicated in patients with active periodontal disease or poor periodontal health because in that case, the chance

for further deterioration of the condition becomes greater. Generally, the benefits of periodontal therapy must outweigh any potential harm. The patient, as the main participant in making decisions about the therapy, has the right to be informed about the benefits and possible risks that can occur during and after the treatment (7).

The effect of orthodontic therapy on soft tissue

During orthodontic therapy, intraoral and extraoral changes in soft tissue can occur which may be the result of direct and indirect damage. Direct damage is caused by parts of orthodontic appliances, so mobile appliances carry with them a risk of tissue injury caused by acrylic and wire components of the appliance (hooks, springs, screws, etc.) (3). Lacerations and traumas on the gingiva and oral mucosa can often occur during orthodontic therapy with fixed orthodontic appliances because of the rubbing contact between the lips and cheeks with wire arches, brackets, rings and hooks, arches especially in places where the wire is longer and puts pressure on the mucosa (8). Even small amounts of continuous tissue trauma, if neglected, can lead to more serious problems such as ulceration or tissue hyperplasia around the parts of the appliance like loops. In extreme situations, the loop can fully integrate into the hyperplastic tissue which requires surgical excision to remove hyperplastic tissue. Therefore, careful workmanship and supervision of such parts of the wire are necessary to avoid problems (3). Palatal and lingual arches can also cause trauma to the palate or tongue. Extraoral appliances (Hedger and facial mask) can cause injury if patients are restless during sleep or due to rough play (8). Some materials that are used in orthodontics can cause allergic reactions in patients, and then is indirect damage caused by materials used in orthodontics. Nickel present in orthodontic appliances (brackets, rings, and wire arches) is responsible for the occurrence of allergic reactions in patients allergic to nickel (9). Latex present in gloves, elastic bands and elastomeric chains can also cause reactions in patients allergic to protein antigens present in rubber (10). Methyl methacrylate which is present in adhesives and composites is responsible for the occurrence of allergic reactions, but they are somewhat rarer (11). Allergic reactions can vary from damage in the form of ulcerations, and

erythematous lesions, to the occurrence of anaphylactic shock (3).

Soft tissue damage related to implants

The introduction of mini-implants in orthodontics as absolute skeletal support has led to their use in critical situations. Their unique design and simplicity of installation make them comfortable for patients. However, potential problems and complications of soft tissues are common. There are complications recorded in literature in the sense of soft tissue trauma above the implant, periimplantitis and implant fracture during removal (12).

The effect of orthodontic therapy on the periodontium

The presence of an orthodontic appliance increases deposit retention reduces the effectiveness of daily oral hygiene maintenance (13). Most of the studies report on the increased results of plaque index (PI) within 1 to 3 months after installing the device (14,15). Microbial changes begin in a short period after the beginning of orthodontic therapy and include an increase in the number of pathogenic bacteria, such as spirochete, fusobacteria, facultative anaerobes, lactobacilli and *Prevotella intermedia* (16). In orthodontic patients, there is an increased number of cocci and rod-shaped forms in comparison with those that do not wear orthodontic appliances. The number of cocci decreases up to six weeks, whereas an increase in spirochete and rod-shaped forms is recorded. Changes in microbiological composition in orthodontic patients can be the result of reduced plaque control, but also of the very appliance which can influence changes in microbiological composition (13). Orthodontic appliances also increase the possibility of the occurrence of fungi in the subgingival biofilm, and one research report on a threefold increase in the prevalence of fungi in patients with orthodontic appliances compared to those without them (17). Of the fungi, *Candida albicans* was the most commonly present (47,2%) in patients with both gingivitis and periodontitis, and of others, one could also find: *Candida parapsilosis*, *Candida dubliniensis*, *Candida tropicalis*, *Candida gilliermondii*, *Candida sake* and *Rhodotorula spp.*(16). Plaque is the main etiological factor in the development of gingivitis. Experimental studies in animals have shown that in the absence of

plaque, orthodontic forces and teeth movement does not cause gingivitis. However, in the presence of plaque, similar forces can cause bone defects, and with intrusion and tipping tooth movement, there can also be a loss of tooth attachment (18). In addition to a plaque, mechanical irritation caused by orthodontic rings or cement is cited as a cause of gingival inflammation. A histological study conducted on human periodontal tissue confirmed that orthodontic appliance placement must be performed with great care, followed by excellent oral hygiene to avoid permanent periodontal destruction (18). Periodontal complications as consequences of orthodontic therapy can be present in different forms among which are the most common: gingival hyperplasia, gingival recession, gingival invagination, periodontitis, loss of alveolar bone, dehiscence, fenestration, black triangles, etc. (19). Gingival hyperplasia is very common occurrence in orthodontic patients which is characterized by the increase in gingival volume, especially in its marginal and papillary part, which can result in pseudo pockets with or without the loss of attachment. The main factors in the formation of gingival hyperplasia are considered to be large accumulations of bacterial plaque. Among other factors, chemical irritation produced by the materials used for gluing brackets, mechanical irritation by orthodontic rings and food impaction is often mentioned (20). Some authors have also assessed the possible role of an allergic reaction to nickel which is released from orthodontic appliances made from stainless steel. In vitro and in vivo studies show that released nickel ions can cause an allergic reaction that depends on exposure time and which is characterized by increased proliferation of keratinocytes and epithelial cells (20,21,22). As for bone loss, it was shown that orthodontic patients suffer from a greater bone loss than patients who do not undergo orthodontic therapy, although this difference is generally not of clinical importance. One study found that orthodontic patients experienced 0.23 mm greater bone loss as measured radiographically and that with post-extraction space closure, retracted canines and serial extraction cases were at greater risk of bone loss (14). The appearance of "black triangles" is a condition whose occurrence is more influenced by factors related to the patient than by the therapist. According to current literature, black triangles between maxillary

central incisors and the cervical edge of the gingiva are a direct consequence of orthodontic therapy. Adult patients are at a greater risk because they often have some dental conditions which can complicate treatment, like tooth abrasion, poorly formed substitutes and periodontal diseases (19).

Root resorption associated with orthodontic treatment

Tooth root resorption is a physiological or pathological process during which there is a loss of cementum, dentine and part of the alveolar bone. Resorption in the milk dentition is a normal physiological occurrence, which results in the replacement of milk teeth with permanent ones, whereas the process of root resorption in permanent teeth has a pathological basis (23). According to that, root resorption can be divided into internal (inner) or external (outer) (24). External root resorption is classified into at least 3 categories: surface resorption, inflammatory resorption and replacement resorption (25). It can be localized anywhere in the root, but most commonly it is periapical. Surface resorption is stopped when the cause of its occurrence (usually pressure, trauma) is removed, and cement is repaired. Inflammatory resorption occurs in the necrotic and infected pulp when bacteria and endotoxins pass through dentinal tubules at the surface of the root. By removing the irritation external resorption is stopped (25). Replacement resorption or ankylosis is associated with damage to a large root surface, with which there was a destruction of the periodontal ligament and cementum. External apical root resorption (EARR) is a common iatrogenic consequence of orthodontic treatment. By examining literature related to external root resorption and orthodontic treatment, Weltman (26) presented several critical observations. First, the incidence of EARR after orthodontic treatment is 73% (discovered radiographically). Cross-sectional studies, as well as longitudinal studies, show that EARR does not present a great problem for an average orthodontic patient, with radiographic moderate resorption of less than 2.5 mm. Resorption this size does not have negative clinical consequences, but 1-5% of orthodontic patients have a more severe form of EARR (defined as larger than 4 mm or one-third of the basic root length). Severe root resorption mostly

affects maxillary incisors, then mandible incisors and mandibular first molars. EARR this size endangers the relation between the length of the crown and the root and it can result in tooth mobility (26,27). Intrusion is, according to literature, probably the most harmful direction of tooth movement, although the distance of the apex of the tooth that moves is often correlated with the degree of root shortening (26). Root resorption most often occurs at the top. The ethiology of external apical root resorption, which results from orthodontic therapy, is manifold and it constitutes a wide range of factors that are associated with orthodontic treatment and factors related to the patient. They can be categorized as biological, mechanical and combined biological and mechanical factors (28). When EARR is discovered during orthodontic treatment, it is going to progress as long as the treatment lasts. At that moment it is important to familiarize the patients with the problem. If they decide to continue with the orthodontic treatment, further radiographic monitoring of the patient is recommended. Also, it is necessary to apply mild forces and alternately activate the wires of the upper and lower arch, for example, once in 2 to 3 months activating each arch instead of doing so monthly.

The connection between orthodontic treatment and infective endocarditis

The relationship between orthodontics and infective endocarditis is not entirely clarified. Although controversial, it is generally assumed that there are correlations between poor oral hygiene, the severity of periodontal disease, the type of dental procedure, and the frequency, nature, size and duration of bacteraemia. However, evidence supports that good oral hygiene, without dental diseases, will reduce the frequency of bacteraemia which arises from daily activities (29). It is still not clear which clinical procedures in orthodontics can potentially result in the development of infective endocarditis. The assumption is that the placement of orthodontic rings could result in bacteraemia. In one of the rare studies on this topic, the authors state that they were able to detect bacteraemia in 10% of blood samples taken during the placement of orthodontic rings (30). On the other hand, another group of authors did not detect microorganisms in the bloodstream during the placement of

orthodontic rings in their research (31). This obvious contradiction in the results of similar research could be a consequence of different techniques and difficulties in the detection of bacteraemia in general since the studies are of an older date. On the other hand, the explanation could be sought in the fact that during the ring placement procedures bleeding does not always occur, nor does the registered bacteraemia that could cause infective endocarditis (32). The procedure of teeth cleaning and polishing, to prepare patients for placement of fixed orthodontic brackets, could be connected to the occurrence of bacteraemia. It, therefore, follows that this procedure could consequently expose a predisposed patient to the risk of infective endocarditis, which is why antibiotic prophylaxis is necessary for the placement and removal of rings, and therefore also for teeth polishing (33). In their guidelines, "American Heart Association" did not recommend antibiotic prophylaxis during the adjustment of orthodontic appliances. Similarly, taking impressions for study models was not associated with the occurrence of bacteraemia (which could cause infective endocarditis) and does not require antibiotic prophylaxis (29). Extraction of impacted teeth (especially upper canines) is a surgical procedure that could lead to bacteraemia and requires antibiotic prophylaxis in high-risk patients. Once the tooth is fully extracted, the surgery site can be observed in the same way as the extraction or eruption site and does not require additional antibiotics. Studies show that the procedure of excision and tooth extraction carries a lower risk of bacteraemia than tooth extraction using the lobe technique (29).

Failure of orthodontic treatment

Failure to complete orthodontic treatment is frustratingly common and is as high as 4-23% (34). It can occur as a result of the patient's insistence to remove device earlier for personal reasons or the orthodontist's assessment that further continuation of treatment could endanger tooth and periodontal health due to serious root resorption. Sometimes patients do not adequately maintain oral hygiene and do not follow instructions given by the orthodontist resulting in the worsening of periodontal problems and frequency of white spot lesion thus requires early removal of the appliance (34). The failure of

treatment most often occurs as a result of irresponsible behaviour on the part of the patient, incorrect diagnosis and wrong treatment management. The patient's attitude towards treatment plays very important role in ensuring predictable and successful therapy outcomes. Sometimes treatment can, also, be unsuccessful due to wrong diagnosis and poorly formulated therapy plan. It could often be due to unforeseen circumstances such as the growth of the lower jaw in skeletal class III above the expected age which is mostly under the control of hereditary mechanisms that are difficult to predict but must be taken into account. Recognizing and acknowledging one's limitations is very important in avoiding treatment failure. This especially applies to situations when orthodontists try to treat surgical cases only with orthodontics, with poor results, either due to patients' coercion and their insistence on non-surgical treatment or due to an incorrect diagnosis. To avoid these situations, it is important to advise the patient and explain the limitations of certain treatment protocols and establish treatment goals before it begins. Advances in digital devices are an advantage for a clinician because they enable the visualization of treatment goals and can be used as an educational and motivational tool for the patient. Treatment goals and results are visualized to the patients even before the treatment begins, with the help of new software programs, which ensures better patient compliance and motivation right at the beginning of the treatment (3).

Conclusion

Iatrogenic effects of orthodontic treatment can be classified into two groups: local and systemic. More serious damage is, fortunately, a rare occurrence. Before beginning orthodontic treatment, both the patient and the orthodontist should consider the benefits, an also risks of the proposed treatment. Correct diagnosis, detailed treatment plan, regular check-ups and timely intervention, as well as good cooperation between the patient and orthodontist, are key to the success of any orthodontic therapy. Most of the harmful effects of orthodontic therapy can be avoided by taking certain precautions during the treatment.

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