Orthodontic treatment of dogs on the basis of modern knowledge and own experience

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Abstract

The aim of the study was to demonstrate the orthodontic treatment of malocclusions in dogs, a condition which can lead to cranio-mandibular and functional disorders of the stomatognathic system. The treatment involved the use of maxillofacial-orthopaedic appliances, which type depended on the type of disorder and the degree of malocclusion. The applied treatment induced changes in the alveolar bone. Throughout the process of the treatment a great attention was paid to regular brushing off the orthodontic appliance using antiseptics for prophylactic prevention of inflammation of gingival tissue and the palate caused by food getting stuck in the spaces between the teeth.

Keywords: dogs, malocclusions, orthodontic treatment, orthodontic appliances.

Introduction

Malocclusions in animals are not only an aesthetic problem. They are primarily a disorder of the chewing apparatus, leading to cranio-mandibular dysfunctions and functional disorders of the stomatognathic system. General classification distinguishes between congenital and acquired malocclusion. Congenital defects occur in utero, as a result of genetic factors. By contrast, acquired defects develop during postnatal life and result from environmental factors (16). Orthodontic treatment of inherited malocclusion should be only conducted when the patient has been castrated and eliminated from further breeding (6). Dental occlusion defects often result in damage of the periodontal tissue or palate. They cause rapid development of periodontal disease and a considerable pain. This problem is frequent in dogs, but it is also encountered in cats. Prior to treatment, the cause of the disorder, age of the patient, as well as the type and severity of the abnormality should be determined (10, 16). Because of the consequences associated with dental displacement, such defects should be diagnosed as early as possible so that appropriate steps can be undertaken to inhibit or eliminate the defects completely (2). The treatment of malocclusion prevents from periodontal disease and premature wear of teeth crowns. In younger patients, simpler and shorter treatment can be applied to achieve
a satisfactory therapeutic effect. Patients with still growing bones are less resistant to orthodontic teeth movement and their soft tissues are more flexible. Their cells are in the active growth phase and exhibit high adaptability to ongoing changes. In such conditions, it is easier to achieve teeth movement (23).

Material and Methods

Material consisted of 4 dogs - patients of the Department of Surgery, whose owners volunteered because of the prevalence of malocclusion leading to functional disorders of the stomatognathic system. The treatment plan, selection of methods and orthopedic appliance was dependent on the type and degree of disorder. The following devices were used: an orthodontic bracket with buttons on which a flexible chain was strung and the Schwartz plate appliance made of acrylic with Fischer screw built-in. Another appliance was used to move incisors to the line of mandibular dental arch. It was a specially designed appliance with a steel wire running from the tongue side towards both incisors. The main purpose of the treatment was to restore proper occlusion and function of the masticatory system.

Results

Before the orthodontic treatment, it was necessary to perform proper diagnosis, which included: a general intraoral and extraoral examination, assessment of occlusal conditions and symmetry of the skull, X-ray examinations, and diagnostic models. Diagnostic models were prepared after taking an impression of the upper and lower dental arch and casting plaster control models (Figs 1, 2). The treatment plan involved the use of the maxillofacial-orthopedic appliances, which type depended on the kind of the disorder and the degree of malocclusion. Due to the fact that most procedures performed in occlusion treatment required sedation of the animal, it was necessary to conduct additional tests to capacitate the use of anaesthesia. It was also important to perform preliminary periodontal preparation of each patient, which is essential in planning of the treatment. Taking dental impressions, and adjustment of orthodontic appliances were performed under general anaesthesia. The animals were premedicated with atropine (Atropinum sulfuricum, Polfa) dosed at 0.05 mg/kg b.w. and medetomidine (Domitor, Orion Pharma) dosed at 0.04 mg/kg b.w. administered intramuscularly. Subsequently, the patients received 5 mg/kg b.w. ketamine (Vetaketam, Vet Agro) administered intravenously. Dental impressions were taken with the use of impression material (Kromopan, Lascod). Directly before the orthodontic device was applied, the teeth on which it was to be fixed were properly prepared. Dental surfaces were cleared of plaque, rinsed with distilled water, and dried. After initial preparation, the crowns were coated with dental etchant (Etchmaster, Arkona), which was rinsed off after 30 sec. The etched surfaces were then air-dried.

Three types of procedures could be distinguished in the orthodontic treatment, which included dogs diagnosed with four types of malocclusions.

1. Interceptive treatment - extraction or preparation of deciduous teeth and newly erupted permanent teeth that cause occlusion problems in permanent dentition. These disorders result from discrepancies in the growth of teeth and jaw bones. Treatment should be started as early as possible in order to eliminate obstacles or limit the consequences of the emerging problem of occlusion. Interceptive treatment may prevent from the development of incorrect teeth position in the dental arch.
Figs 3 and 4 show the occlusion of a dachshund dog aged nine months with two canines abnormally angled in the nasal direction. Due to the necessity to retract the canines, a decision was made to use an elastic rubber chain, which functions as an active, fixed orthodontic appliance. The anchorage (stabilisation) points of the appliance were placed on multi-root teeth, which allowed the rubber chain to be stretched with a proper force between the maxillary canine and fourth premolar on either side. Orthodontic buttons were attached to the teeth using glass ionomer cement (Chemfil Superior, Dentsply). During the treatment, the rubber chain tension was checked and regulated on a weekly basis by shortening the chain by a given number of links. The appliance was used actively for three months, after which it was retained in an inactive state for another three weeks.

Fig. 3. Incorrect position in the line of occlusion of teeth 404 and 304

Fig. 4. Orthodontic treatment with a rubber chain stretching with moderate tension between the buttons on the canine and the fourth premolar (108)

2. Preventive treatment - the elimination of conditions that can lead to abnormalities in a developing or mature occlusal system. Preventative treatment is divided into three categories: the assessment and supervision of occlusion, spacing control (the effects of post-traumatic, congenital, and hereditary anomalies) and behavioural control. The purpose of this type of therapy is to preserve the integrity of teeth in the dental arch.

Figs 5 and 6 present the occlusion of an Akita inu dog aged 10 months, whose maxillary incisors resided distal to their normal position (101, 201) in the dental arch. An active orthodontic appliance was used comprising a shaped piece of dental wire with steel bands on either end to be anchored onto the two maxillary canines. A rubber band was then fixed between the retracted incisors and the brace to force labial repositioning of the incisors. The appliance was actively used for a period of three months. The retention period was one month.

Fig. 5. Retractation of incisors 101 and 201 in the maxillary dental arch

Fig. 6. The use of a fixed orthodontic appliance to correct maxillary incisors

Figs 7 and 8 present the occlusion of a Bullterrier dog aged eight months. Due to the narrowed space between the canine and the third maxillary incisor, the crowns of the mandibular canines were abnormally angled in the lingual direction. When the mouth was closed, the palate was permanently traumatised by mandibular canines. In order to realign the teeth in the labial direction, a type of a permanent Schwarz plate appliance was used with a central Fischer screw. During weekly visits, the appliance was monitored and an additional turn of the screw added. The orthodontic
treatment lasted four months. After the occlusion was corrected, the appliance was retained in the inactive state for additional two months.

3. Corrective treatment – two-stage treatment: the phase of active treatment and retention. Active treatment refers to the application of a proper occlusion restoring device. It induces accelerated resorption of alveolar bone, so it is important to apply retention after completing the first stage of treatment.

Figs 9 and 10 present the occlusion of an Australian shepherd dog aged nine months suffering from crossbite. The maxillary incisors 101, 102, and 201 were improperly positioned in the dental arch—they resided distal with reference to their counterpart mandibular incisors. The remaining maxillary and mandibular teeth were positioned correctly. For this dog a decision was made to use a steel wire arch (a part of an active appliance) anchored with steel bands on maxillary canines in order to labially realign the incorrectly positioned incisors. A second-order bend was used in the vertical plane with up and down bends. The period of active orthodontic treatment was four months. Once correct occlusion was obtained, the passive appliance was retained for additional three weeks.

During and after the therapy it was observed that the effect of combined periodontal and orthodontic treatment was stable. Therefore, it was important to ensure retention after each orthodontic treatment. It involved the stabilization of the corrected occlusion and teeth position, which conditioned the permanence of the malocclusion treatment results. The orthodontic treatment resulted in induction of resorption and changes in the alveolar bone. The retention phase enabled the alveolar bone tissue to return to a physiological state, which provided a stable and harmonious structure supporting the teeth. Throughout the process of orthodontic treatment, a great attention should be paid to
regular brushing off the orthodontic appliance using antiseptics for prophylactic prevention of inflammation of gingival tissue and the palate caused by food particles left behind in the spaces between teeth.

Discussion

The age of 9 to 15 months is considered as the most favourable period for orthodontic treatment in dogs (16). Various orthodontic appliances are used, with their functions supporting the movement of teeth through the processes of reconstruction of the alveolar bone and periodontium. Tooth movement is based on the reconstruction and adaptive changes in periodontal tissues. Orthodontic tooth movement is significantly different from physiological movement or eruption (10). Orthodontic correction can be achieved through a significant displacement of teeth without causing damage to the periodontium, provided that controlled reduction of tissue inflammation can be ensured. As a result of orthodontic treatment, the shape of dental arches and the position of individual teeth can be corrected while maintaining proper anatomical and functional relationships in the oral cavity and the surrounding structures (2, 13). Orthodontic movement is based on the assumption that the force exerted on the teeth and transmitted to adjacent tissue results in mechanical, chemical, and cellular processes within these tissues, which in turn cause structural changes and contribute to teeth movement. The process of alveolar bone remodelling occurs after a certain time from the beginning of therapy, when the resiliency of bone tissue is defeated (7, 16, 9). The rate of orthodontic tooth displacement depends on factors such as: bone density, periodontal ligament hyalinisation, and bone turnover (1). When using orthodontic appliances in clinical practice, it should be always remembered to use the appropriate amount of force with regard to the direction of orthodontic tooth movement, in order to avoid damage to tooth tissue and ligament (2). Forces used in orthodontic treatment should not cause displacement of a tooth greater than about 0.1 mm per day (16). Forces acting on the tooth cause microscopic, as well as macroscopic lesions occurring in the surrounding tissues. Their effect leads to deformation of the tissue, causing local changes in vascularisation and reorganisation of the cellular and extracellular matrix, which results in the synthesis and release of many neurotransmitters, cytokines, growth factors, and metabolites of arachidonic acid. When treating a patient with damaged connective tissue, orthodontic forces must be reduced accordingly (10, 22). The application of a heavy force causes disorders in the dental pulp, which can lead to necrosis (Fig. 9). Among the most common consequences of the use of excessive orthodontic force are necrosis of the periodontal tissue, horizontal atrophy of the alveolar process, root resorption, and tooth loss (2). Due to the stronger influence of atrophy over apposition of bone, teeth become loosened. Root resorption is an inevitable pathological consequence of orthodontic tooth movement. The point of the active orthodontic treatment is to change the position of teeth in the alveoli, which depends on two factors: the tensile strength and tightness. The balance between atrophy of the oppressed bone tissue (osteoclast activity), and bone apposition (activity of osteogenic cells that leads to the formation of new bone) on the side of the tensile force determine the proper progress of orthodontic treatment (11, 16).

In the assessment of a periodontal condition, the presence of visible plaque, periodontal pocket depth, the occurrence of bleeding during probing, and evaluation of connective tissue attachment, should be taken into account. If not properly planned, orthodontic treatment, especially in the presence of periodontopathy, may lead to a significant acceleration of the destruction of periodontal tissues. In some cases, orthodontic treatment may be used in patients with periodontal changes, but the stage of periodontal disease must be taken into account. The available literature cites numerous reports of cases in which orthodontic treatment of patients with advanced periodontopathy was successful (8, 17, 18). Teeth movement connected with tissue remodelling and the presence of periodontal tissue inflammation can cause pain, particularly after insertion and activation of the orthodontic appliance. The inflammation process induced by tooth movement depends on many factors, including the potential of resorbing cells, as well as the sensitivity of the tissues involved (3). The periodontal tissues reveal the presence of prostaglandins, which are mediators of bone resorption. Chumbley and Tuncay (5) suggest that prostaglandins play a significant role in bone resorption during orthodontic treatment. The authors do not recommend using indomethacin or salicylic acid derivatives in patients undergoing orthodontic tooth movements due to the possibility of extending the duration of treatment as a result of using these drugs. It has been shown that administration of indomethacin induces bone resorption (25).

Orthodontic treatment is a long process resulting in an increased risk of root resorption, inflammation of gingival tissues, and tooth decalcification.
An alternative, and in recent years increasingly used procedure to shorten the duration of treatment is a combination of corticotomy and orthodontic treatment. This procedure involves cutting the bone lamella along a vertical surface of the etched tooth root. In this way, conditions are created, which allow the movement of teeth to accelerate after the application of orthodontic forces (15, 19, 20). The bone lamella cut reduces bone resistance during tooth movement due to the phenomenon of increased bone turnover and bone density decrease (1). Mostafa et al. (14), on the basis of a histological examination, demonstrated greater and more extensive activity in bone remodelling in dogs subjected to orthodontic treatment supported by corticotomy. The authors suggest that the effect of tooth movement acceleration after corticotomy is the result of increased bone turnover, based on a local reaction to acceleration. Other factors precipitating orthodontic treatment include fiberobery and administration of a hormonal treatment with relaxin or prostaglandin E2 (PGE2) (21). Fiberotomy is the surgical procedure of severing the gingival fibres around the tooth. After conducting a study on rats, Young et al. (24) concluded that by combining orthodontic treatment with fiberobery, tooth realignment can be precipitated and the danger of malocclusion relapse is minimised. Similar results can be obtained by the use of relaxin, which affects the remodelling of soft tissue (21). Madan et al. (12) also demonstrated that the application of relaxin may precipitate the orthodontic tooth realignment in rats. In turn, Çağlaroğlu et al. (4) studied the effects of local administration of prostaglandin E2 on bone metabolism and orthodontic treatment in rabbits.

To conclude, because of the implications posed by malocclusions, they should be diagnosed at the earliest possible age and subjected to correction with the use of an appropriate orthodontic appliance. Orthodontic treatment can be applied to prevent from dental and periodontal diseases, disorders of the temporomandibular joints, as well as to ensure general comfort and well-being of the patient. An important part of treatment planning is the determination of the cause of the defect and the type of malocclusion. Through the use of proper appliances, significant teeth displacement can be accomplished without causing any damage to the periodontium. However, it is important to control proper application of force because excess in this respect can lead to highly undesirable consequences.

References