

## TWO YEARS OF PREDICTABLE RESULTS WITH COMPUTER-AIDED DESIGN (CAD) AND COMPUTER-AIDED MANUFACTURING (CAM) ORTHODONTIC DEVICES IN ROSTRAL CROSSBITES AND LEVEL BITES IN 12 DOGS

DOI ANI DE REZULTATE PREDICTIBILE CU APARATE ORTODONTICE CU DESIGN ASISTAT DE COMPUTER (CAD) ȘI REALIZATE CU AJUTORUL COMPUTERULUI (CAM) ÎN TRATAMENTUL MUȘCĂTURII INVERSE ȘI CAP LA CAP ROSTRALE LA 12 CÂINI

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### ABSTRACT | REZUMAT

Rostral crossbites and level bites are considered traumatic and unstable occlusions in both humans and dogs. In the long process of searching for treatment solutions for dogs, authors have tried to implement different solutions with poor and less repetitive results. This may be due to the increased mastication forces developed in the canines' oral cavity. This article wants to report our predictable approach to these bites. Twelve owned dogs were addressed for this kind of pathology. Impressions were taken standardly; impressions were scanned and entered into the process of computer-assisted design (CAD). After analysing the cases, the orthodontic devices were computer-aided manufacturing (CAM). Results were obtained between two and nine weeks. No pink teeth appeared as a consequence of the orthodontic treatment. A six-month check-up after removing the orthodontic devices revealed that the results were stable. All of the dogs in the study were neutered.

**Keywords:** malocclusion, orthodontic device, dogs, veterinary dentistry

Mușcăturile inverse rostrale și cele cap la cap sunt considerate ocluzii traumatice și instabile atât în cazul oamenilor cât și în cazul câinilor. De-a lungul timpului, încercând să găsească soluții terapeutice pentru câini, autorii articolului au încercat să implementeze diferite soluții terapeutice cu rezultate slabe și mai puțin repetitive. Cel mai probabil aceste eșecuri s-au datorat forțelor masticatorii crescute care se dezvoltă în cavitatea orală a câinilor. Acest articol dorește să raporteze modul predictibil de rezolvare al acestor patologii. Doisprezece câini cu proprietari s-au adresat pentru remedierea mușcăturii. Ampretele s-au realizat clasic, apoi au fost scanate și au intrat în procesul designului asistat de computer (CAD). După analiza cazurilor, aparatele ortodontice au fost realizate cu ajutorul computerului (CAM). Rezultatele au fost obținute între două și nouă săptămâni. Niciun dinte nu s-a colorat în roz în urma tratamentului ortodontic. Controlul la șase luni după îndepărtarea aparatelor ortodontice au arătat stabilitatea rezultatelor. Toți câinii incluși în studiu au fost sterilizați.

**Cuvinte cheie:** malocluzie, aparate ortodontice, câini, stomatologie veterinară

Every animal deserves a non-traumatic occlusion free of discomfort (6). Some terms should be clarified to understand what crossbite and level bite are. Occlusion, or bite, is the term that defines the contact between maxillary and mandibular teeth in a closed mouth. Ideal occlusion is one that does not harm the individual, has an equal distribution of the mastication forces. Normal occlusion, as veterinary dentistry standards define it, implies: Incisors: maxillary ones are rostrally positioned to the mandibular ones, having contacts between the incisal tips of the lower ones and the cingula of the upper ones; Canines: mandibular

ones are situated between the third upper incisor and the maxillary canine; Premolars: Maxillary and mandibular premolars do not have any contacts. The crown cusps of the mandibular ones are situated lingually next to the ones of the maxilla. The mesial cusp of the upper carnassials is localised lateral to the space between the fourth mandibular premolar and the first mandibular molar (9). Normal occlusion is known as a *scissor bite*. This dental interlock prevents normal rostral growth of the mandibles (1). Malocclusion defines abnormal relationships between the maxilla and mandibula. Both human dentistry and veterinary dentistry recognise three classes of symmetrical skeletal malocclusions: Class 1 – Neutroclusion is when the relationship between the jaws and the teeth is normal and one or more individual teeth have a malposition. Class 2 – Mandibular distocclusion is when the mandibular

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dental arch occludes distal or caudal to its normal position. Class 3 – Mandibular mesioocclusion is when the mandibular arch occludes rostral to the normal position (15). *Crossbite* in dentistry is known as inversed occlusion. Thus, maxillary circumscribing is not present. Crossbites may be rostral or caudal. This may be a consequence of a dental or skeletal malocclusion. In the *rostral crossbite*, the relationship between one or more incisors is inverted. Usually, it may be due to palatally positioned upper incisors and labially positioned lower incisors. *Level bite* is the term that describes the edge-to-edge contact between the two dental arches. *Rostral-level bite* refers to edge-to-edge contact between one or more incisors. The anchorage of orthodontic devices may vary from standard brackets to personalised anchorage devices. CAD-CAM methods have changed how dental devices, prosthodontics, and orthodontics are designed and made (2).

Orthodontic computer-assisted planning and designs allow the team to create multiple simulations to facilitate communications between the team members, and it is more intuitive to explain to the owner. At the same time, different simulations of the future device may be obtained in less time. Using the Virtual planning systems (VPS) and three-dimensional (3D) printing, veterinary orthodontics has stepped into a new stage (13).

## MATERIALS AND METHODS

Twelve cases were included in the study. The criteria to be introduced in the study was rostral crossbite and rostral level bite with class 1 neutral occlusion.

Eight cases presented cross-bite and four-level bites. After diagnosis and discussions with the owners about expectations, commitment, fees, and the number of appointments, minimal blood tests were taken to evaluate the general medical condition. After confirming that patients can undergo multiple general anaesthesia in the near future, impressions were taken with hand-mixed impression material with prolonged stability. Condensation silicone was used for impressions.

All together with the technical team, information was exchanged to get maximum results with the computer-assisted-designed orthodontic devices.

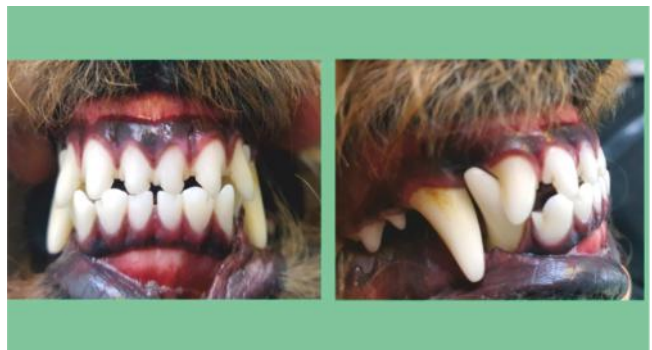
All cases received an arch metal bar anchored on the maxillary canines. The bars have buttons for elastic chains. The devices placed on teeth were metal crowns that were attached to the vestibular side hooks for elastic chains. Even more, on the incisal edge, crowns would have had an inclined plane so that in the retaining period, crowns would remain in place. Mandibular incisors were loaded with information and placed on metal crowns.

If the case presented a crossbite, besides the in-

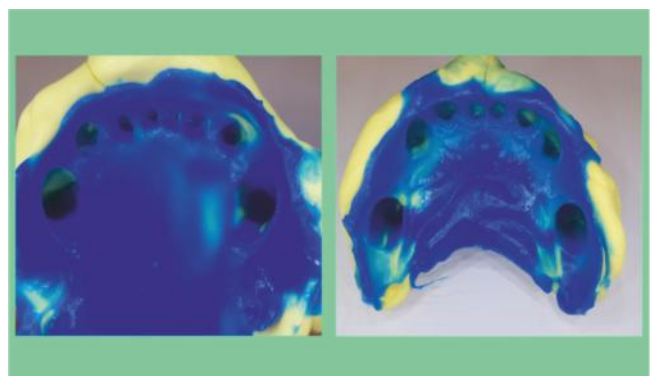
clined plane placed on the incisal edge, crowns would have hooks for elastic chains anchored on orthodontic implants placed between the roots of the third lower premolar. The technical team delivered the orthodontic pieces on model casts.



**Fig. 1.** Rostral crossbite with class 1 /neutral occlusion



**Fig. 2.** Rostral level bite with class 1 /neutral occlusion

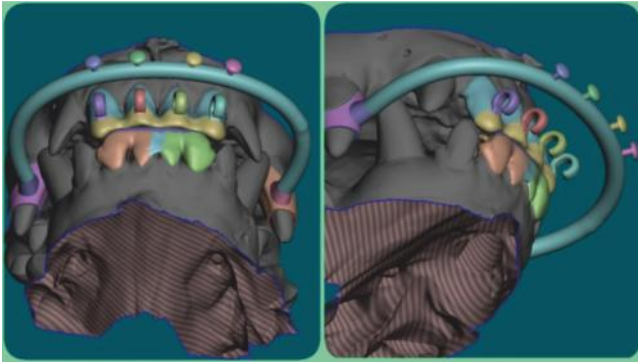


**Fig. 3.** Image of the impressions of the maxilla and mandibula taken with condensation silicones. Impressions were scanned, and virtual models were obtained with 3D planning software.

On placement, the first activation occurred.

The time between activations was at least three weeks and a maximum of four.

Retainers were held for up to three months.



**Fig. 4.** Virtual models of future orthodontic devices



**Fig. 5.** Arch bar with crown on the cast models

## RESULTS AND DISCUSSIONS

Orthodontic treatment with orthodontic devices consists of two stages: active treatment, when forces are applied to the teeth that need to be moved, and retention. Retention consolidates the results, allowing the alveolar bone to deposition, remodel, grow, and mineralize, thus stabilising the teeth in the corrected position. Orthodontic devices used in active treatment are, in most cases, different from the ones that retain the results, named retainers. While the active devices induce resorption of the bone, retainers allow the bone to return to a physiologic state in the new position. The forces that are applied should provide enough force to move the needed teeth and have the lowest levels of complications or discomfort for the patients. (14)

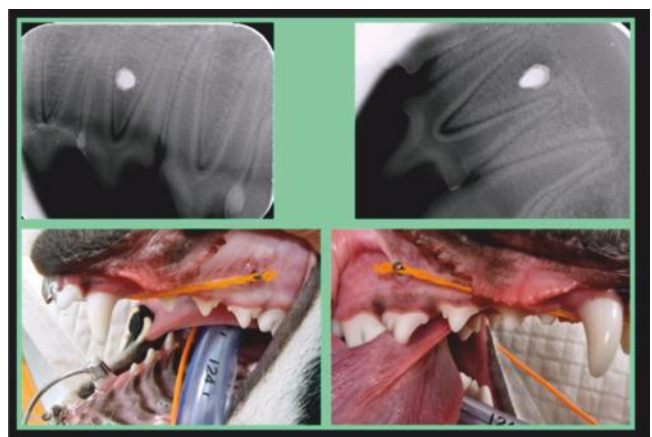
Two studies by Smith and Massoudi (1991, 1992) showed a correlation between the root area surfaces and the applied force (11, 12). Thus, these forces must be correlated with the dog's weight, breed, and teeth. If the force is mild, the desired response of initiating cellular activity resorption and bone deposition will lead to physiologic movement of the teeth. When pressure increases, necrosis of the periodontal ligament will occur on the pressure side, and resorption of the root surface and poor or no bone deposition will be obtained. The orthodontic approach should be performed only when rostral crossbite and level crossbite

are associated with class 1 occlusion and never when associated with class 3 occlusion. Legendre and Peak have proposed for moving teeth universal screws, memory wires, labial and lingual arch bars, inclined planes, or even more complicated surgical interventions. (5,8) Orthodontic devices CAD-CAM designed, our choice, fitted perfectly in the oral cavity of the patients. Metal crowns offered reliable, long-term stability for the orthodontic forces and did not fall or traumatised the patient.



**Fig. 6.** Intraoral image of the orthodontic device placed into the oral cavity of a dog

Orthodontic implants positioned between the roots of the lower premolars (to lingualize the lower incisors) did not affect the vitality of the teeth and offered good stability for the needed period of orthodontics. They were removed at the last appointment, when the orthodontic treatment ended. Dog breeds have three types of skull conformation: long-dolichocephalic, medium-mesocephalic, and short-brachycephalic. Dolichocephalic breeds have long, narrow profiles; mesocephalic breeds have balanced, well-proportioned skulls; and brachycephalic breeds have a pronounced mandibular prognathism. These classifications are strictly medical and do not refer to breed standards.



**Fig. 7.** Clinical and radiological aspects of the orthodontic implants



Regarding the skull type, 8.33% of the patients were dolichocephalic, 41.67% were mesocephalic, and 50% were brachycephalic. These results show that the brachycephalic owners were more aware of the medical issues a brachycephalic breed would imply. Even more, as is standard in breeding, Rottweilers go in a direction where the face is getting more flattened. Three of our cases were Rottweilers. None of the rottweilers' that addressed us had blood bonds. The median age for addressing orthodontic treatment was for brachycephalic dogs 9,8 months versus 12,33 months in mesocephalic. The median time for malocclusion correction was shorter in brachycephalic breeds, 2,8 months versus 3,33 in mesocephalic dogs. These results reside in the fact that the oldest patients, who addressed orthodontics at 24 or 26 months of age, were mesocephalic. Even more, bone disponibility in brachycephalic dogs is considerably less than in mesocephalic dogs, so that the movement of the teeth has a lower volume of bone that needs to be rearranged due to orthodontic forces.

The youngest patient that addressed orthodontic service was 5,5 months old, and the oldest had two years and two months. Regardless of the breed, results were significantly earlier obtained if the first appointment was at a younger age.

One-third of them presented level-bite, and two-thirds presented cross-bite. Crossbites are considered traumatic occlusions that lead, over time, due to painful complications. Thus, in a crossbite, the upper incisors will bite on the lower ones, developing paraxial forces impinging the periodontal ligaments, causing mobility of the teeth and pain. The upper ones will develop periapical reactions due to these abnormal, increased forces. First, the vascular-nervous package of the upper incisors will be compressed; necrosis will

occur. Clinical signs will include compromised prehension of food, halitosis, mobile teeth, weight decrease, and, after a long period of suffering in silence, lost teeth. Below (Fig. 8), the table shows the evolution in time for each case.

Edge-to-edge contact is even more traumatic than a crossbite. The forces developed and the unstable contacts upon the incisal edges will cause fractures, attritions, impingement of the periodontal ligament, mobility, displacement of the involved teeth, pain, halitosis, and eventually loss of teeth.

Rostral crossbites may have different aetiologies, ranging from persistent deciduous teeth (4) to vicious templates of playing or growth spurts (3).

The median time for correcting the level bite was 1,5 months, versus 2,75 months' median time needed to correct the crossbite. Crossbite owners came earlier; still, the period for correction was longer. This is because a crossbite looks more unusual than a level bite, and it can be easily diagnosed by non-specialists. Ten cases were males, two females. The median age in males for addressing veterinary orthodontics was nine months, and for females, it was 6,25 months. Even though there was no significant difference in the time for correction by gender (2,75 months), the results were positive for all of the cases.

The aetiology of malocclusion may vary and may be associated with dental ones, which are simple to manage, while jaw misalignment is more challenging. We approached only the ones with dental problems.

None of the dogs presented at the end of the treatment any pink teeth. Pink teeth did not appear as a consequence of the orthodontic treatment.

All of the dogs in the study were neutered according to the international conventions for responsible breeding.



Fig. 8. Evolution of each case in time



**Fig. 9.** Before and after intraoral images.

The upper row reflects the intraoral situation before orthodontic treatment, and the lower row is after orthodontic device removal

### CONCLUSIONS

The oral cavity should be examined during the veterinary doctor's first visit. A good selection of the cases is imperative. Successful orthodontic cases require good communication between the dental team and owners. Owners' commitment is one of the most critical factors. Virtual planning offers more precise solutions and enhances communication with the technical team and the owners.

Arch bars with buttons for elastic chains are stable and offer an excellent anchoring place for moving upper incisors. Inclined planes properly maintain the vestibularization of the upper incisors. Lingualization of the lower incisors may be obtained by elastic chains anchored on orthodontic implants placed between the roots of the lower premolars. Once the maxillary incisors overlap the mandibular ones, a stable, long-term occlusion is obtained.

Placing the orthodontic implants between the roots of the lower premolars requires experience and solid knowledge of the anatomical landmarks. There were two cases of overcorrection, with maxillary incisors overlapping the mandibular ones, but at six months of follow-up, the occlusion was the ideal one. This was due to the balance offered between the tongue and lips, known as a functional corridor.

Orthodontic treatment in veterinary dentistry should be performed only by experienced individuals, as complications due to high forces and unstable orthodontic appliances may lead to painful accidents. Dogs with malocclusions should be removed from reproduction. Responsible breeding is mandatory.

More studies are warranted.

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