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Clinical and histological alterations in the surrounding periodontium of dog's teeth submitted for an intrusive luxation

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Abstract – The clinical and histological alterations on periodontium of dog's teeth after an intrusion luxation was analyzed. An impact device was used on 12 teeth of six adult dogs with the purpose of making a dislocation on the long axis of these teeth. Of the teeth that suffer intrusion luxation, two did not receive treatment and ten were replaced by orthodontic extrusion with activated springs of 100 gf. The traction was initiated either immediately after the trauma or 7 days later. Observation time was 40 days. Endodontic therapy with calcium hydroxide was performed on the fourteenth day after the intrusive luxation. The intruded teeth that did not receive appropriate treatment had signs of extensive and progressive inflammatory resorption. The teeth that were moved immediately after the trauma had lesser degree of replacement resorption compared with those that were extruded 7 days after the trauma.

Intrusive luxation compromises the longevity of the tooth and frequently evolves to such severe complications as pulpar necrosis, obliteration of the pulpar canal, radicular resorption, replacement resorption (ankylosis), and loss of supportive marginal bone (1). Because of the severity of the damages to the periodontal ligament, pulp, and alveolar bone, the handling of intrusive luxation is challenging and requires an interdisciplinary approach among endodontics, orthodontics, and periodontics seeking efficiency in the management and unleashing less collateral effects of the structures involved. The three most common forms of treatment consist of awaiting spontaneous re-eruption, repositioning surgically, or using traction with orthodontic instruments.

The first option is better for permanent teeth with incomplete rizogenesis, where the eruption potential and periodontal and pulpar healing are propitious (2–5). The second option was not recommended by Andreasen (6), Andreasen and Pedersen (7), and Andreasen and Andreasen (8), because during the replacement procedure, adverse disarticulations and possible additional damages to the periodontal ligament resulted in a high risk of ankylosis and loss of marginal bone. Those who defend surgical replacement (9, 10) state that the recovery on the surrounding periodontium occurs normally, even after two consecutive traumatic events. The third option of treatment is considered as a fast and biological alternative to the replacement of the tooth that underwent intrusive luxation (11). The ideal moment to initiate orthodontic traction is a matter of controversy in the literature. The initial recovery of the periodontal ligament after intrusive luxation is expected by some authors (1, 3) who recommend orthodontic traction after a couple of days. Others believe that the orthodontic procedure should be started immediately after the trauma, thus avoiding the formation of bone bridges in places where the compression of the periodontal ligament results in local necrosis, which may lead to exposure of the radicular surface and the possible development of replacement resorption (11, 12, 13, 14).

The repercussion of the intrusive luxation in structures of the periodontium and the ideal moment to initiate the orthodontic traction with its possible advantages and disadvantages were the main purposes of this study, which took into account the unpredictability of dental trauma and each organism's individual response.

Material and method

A study was conducted on the clinical and histological aspects on the surrounding periodontium of the anterior-superior teeth of six dogs aged between 12 and 24 months, corresponding to a young adult of the species *Canis familiaris* of undefined breed. Their teeth were submitted to dental trauma on the long axis. The procedures which involved trauma, setting up orthodon-

tic instruments and endodontic treatment were performed under profound anesthesia. In the simpler and quicker procedures which involved periodical activations of the spring for orthodontic extrusion, sedation with 0.1 mg kg^{-1} of Ketamin chloridrate (Ketamin-Cristália S/A, São Paulo, Brazil) and 0.1 mg kg^{-1} of Dihidrothyazine chloridrate (Rompun Bayer S/A, São Paulo, Brazil) was induced intramuscularly.

The animals were sent for scraping of the dental calculus followed by sensible prophylaxis. The conditions of oral hygiene and gingival health were maintained during the whole experiment through manual brushing at weekly intervals. Periapical pre- and post-trauma radiographies and the endodontic treatment procedures were taken according to the centric–bicentric technique. The *brackets slim* were set up in the anterior-superior segment, corresponding to the animal's six incisors with the exception of the intermediaries, which were submitted for intrusive luxation. Segments of stainless steel line ($0.019'' \times 0.025''$ in width) were adapted in a passive manner from lateral incisor to lateral incisor on the opposite side in each dog.

The trauma was executed with the aid of a device for impact developed by the Department of Mechanical Trials of the Military Engineering Institute (Fig. 1). The laboratory test trials of this device revealed an impact energy of 13,26 J, which was dissipated above the superior intermediary incisors of the experimental animals at the moment of the trauma.

After intrusive luxation, hooks were glued and tied to the vestibular face of only one of the selected incisors for immediate traction procedure. Helicoidal traction NiTi springs were inserted in the rectangular arch by one of its extremities and the other extremity tied to lingual hooks. The springs were activated with 100 gf (gram-force), measured by a previously calibrated tension measuring device. Seven days after the trauma, immediate traction of the homologous incisors began, which also suffered intrusive luxation. Every 14 days, the size of the spring was reduced until the tooth returned to its original position, as a consequence, orthodontic extrusion stopped. Following was the contention of the teeth with Amarillo line 0.008″, which was carried out by fixing them vertically from the lingual hooks to the segmented arch, and which remained for 14 days.

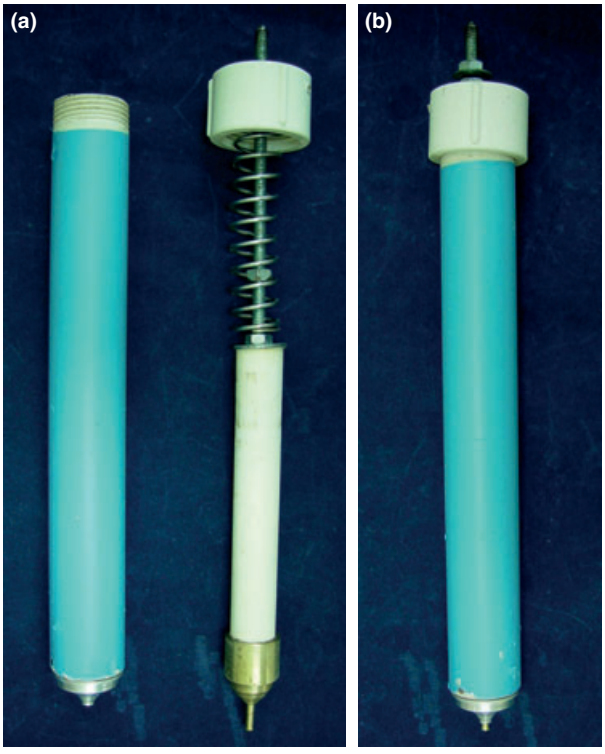

Fig. 1. Device that promotes the intrusive luxation. The activation was made by compression of the spring.

The teeth that suffered intrusive luxation received endodonthic therapy and filling up of the radicular canal with calcium hydroxide paste in aqueous solution was carried out after 14 days. The animals were sacrificed 40 days after the intrusive luxation, received longitudinal cuts in relation to the long axis of the teeth and were colored with hematoxylin and eosin.

The microscope used to analyse the tissue alterations was a Leitz Wetzlar ERGOLUX AMC (ERGOLUX, Austin, TX, USA) with 3 generic objectives 4×/0.1, 10×/0.25, 40×/0.65.

Results and discussion

Comparisons between human alveolar bone and animal alveolar bone of dogs and primates revealed that the alveolar bone in animals is denser, even in young animals. The high density of the bone in animals occurs because of the filling up of the medullar spaces, leading to more extensive areas of hyalinization, resulting in slower dental movement (15).

Because of the differences present, the tissular alterations observed in the sustentation periodontium of the animals used in the research were confronted with equivalent areas of control animals utilized in a previous study (16), whose characteristics showed this species' patterns of normality.

The control teeth were submitted for intrusive luxation and remained for 40 days in observation, without the realization of any kind of additional treatment. From the middle to apical thirds were noticed resorption lacunae of the radicular surface with irregular margins that reached cementum and dentin. These lesions were filled with inflammatory infiltrate which occupied all the space regarding the periodontal ligament. The periodontal ligament remaining displayed disorganized collagen fibers beam and few fibroblasts, indicating that their repair would be less likely to occur. The blood vessels presented hialinized content (Fig. 2).

The progress of these reactions could lead to the loss of the dental element by the lack of support inherent to the conditions observed in the periodontal ligament, a situation usually seen in teeth which suffered avulsion and did not obtain success with the re-implantation, as related by Anderson (17) and Anderson et al. (18).

In the teeth submitted for immediate orthodontic traction, it was possible to notice extensive resorption lacunae that reached the dentin with deposition of cellular cementum in its deeper portions. The blood

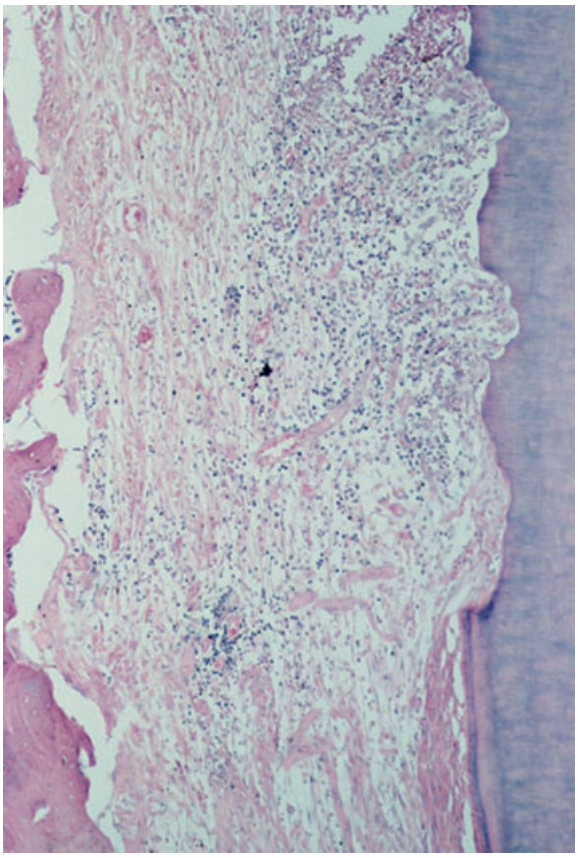

Fig. 2. Lacunae of radicular resorption in the presence of inflammatory infiltrate in the control specimen that was submitted for intrusive luxation and remained in observation 40 days without treatment.

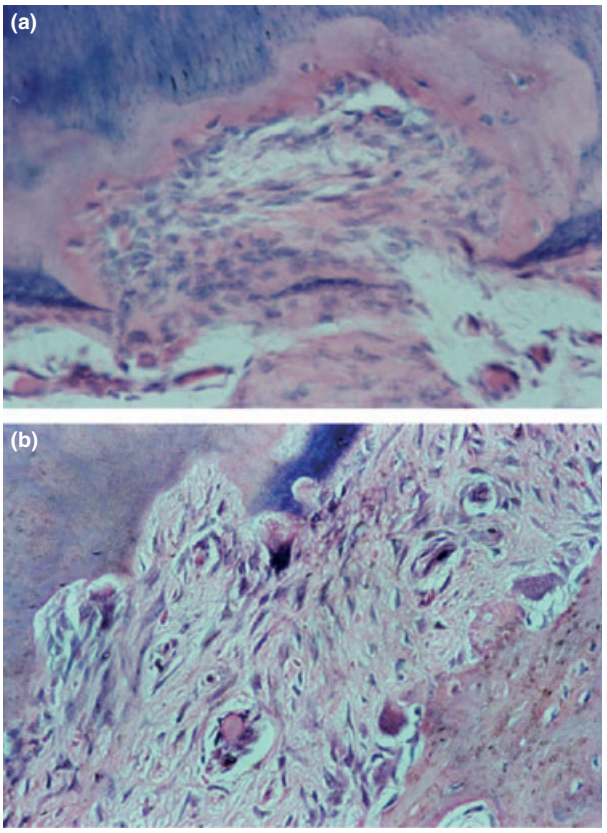

Fig. 3. (a) Radicular resorption with repair by the deposition of cellular cementum in tooth that suffered intrusive luxation and was submitted for immediate orthodontic traction. (b) Irregular margins on the dental and bone surfaces with areas of active resorption.

vessels were dispersed along the periodontal ligament (Fig. 3a). Other teeth presented radicular resorption lacunae reaching cementum filled with conjunctive tissue. Few areas exhibited active radicular resorption. The alveolar bone exhibited irregular margins with resorption characteristics (Fig. 3b).

The presence of lacunae with active radicular resorption was noticed, even after orthodontic treatment was applied with delayed curative made of calcium hydroxide and distilled water, confronting the observations of Tronstand (19). These authors observed that the alkaline pH of the curative neutralized the production of lactic acid by the clastic cells, preventing the dissolution of the mineral components, as it also stimulated the formation process of hard tissue through the activation of alkaline phosphatase. Replacement resorption characterized by the union of the cellular cementum and alveolar bone was observed in the apex of one tooth which was orthodontically tractioned right after the intrusive luxation (Fig. 4).

Although the tooth returned to its original position, the areas of the radicular surface that remained unprotected after extensive necrosis of the periodontal ligament were invaded by osteoclasts involved in bone remodeling, which resorbed dental tissue as they would in the bone, and the osteoblasts repaired the resorbed areas of the root with bone tissue, as reported (20). This

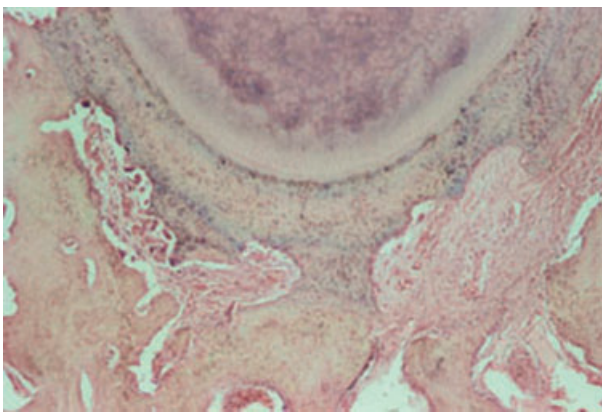

Fig. 4. Replacement resorption (arrows) on the apex of the tooth that suffered orthodontic traction right after intrusive luxation.

phenomenon may have occurred during the period of containment because of the calcium hydroxide curative, whose necrotizing effect on absorption and repair cells would make it possible for the formation of scarred tissue in the form of alveolar bone, depending on the extension of the affected area, which could fuse to the radicular surface (23, 24).

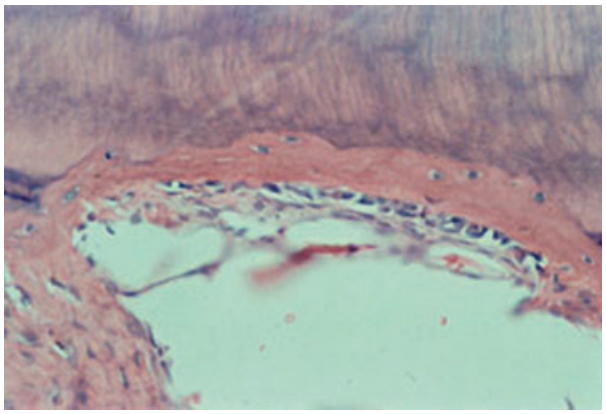

Fig. 5. Repair of the resorption lesions on the radicular surface of the tooth submitted for orthodontic traction 7 days after intrusive luxation.

The teeth that suffered orthodontic traction 7 days after the intrusive luxation exhibited characteristics similar to those tensioned immediately after the intrusive luxation, although the places with presence of inflammatory infiltrate showed themselves more intensely, affecting great extensions of the periodontal ligament. It was possible to observe radicular resorption lesions in great repartory activity with deposition of cellular cementum margined by cementumblasts (Fig. 5). It was frequently observed in this group, a union between the cementum acellular or cellular and alveolar bone characteristics of replacement resorption, even in the teeth that returned to their original position after orthodontic traction (Fig. 6).

In this group, one tooth did not respond to the orthodontic procedure, because it showed repair through the substitution of the resorption of cementum without reaching deeply into the dentin, with the formation of cementum tissue and/or bone in continuity to trabecules (Fig. 7b). The intimate relation of the radicular surface with the alveolar bone with bone bridges already formed before the orthodontic traction might have been responsible for this unfavorable response. In the cervical third, radicular resorption lesions were extensive and reached cementum and dentin, and their re-establishment occurred with the deposition of cellular cementum (Fig. 7a).

The potential effect of replacement resorption can be attributed to the calcium hydroxide delayed curative. In counterpart (14), it was observed that the replacement resorption also occurred before the treatment with calcium hydroxide. Then the periodontal injury could be, in this case, responsible for the replacement resorption (21, 22).

By this way, the susceptibility of the organism, the direction and absorption of the impact by the periodontal structures and even the containment and conditions of the periodontal ligament might have influenced the healing of the structures involved in the trauma. The teeth that suffered traction immediately after the intrusive luxation had a fast return to their original position, decreasing the possibility of replacement resorption before initiating the orthodontic procedure, as was suggested by Cvek (14), Oulis et al. (11) and Andreasen and Andreasen (8).

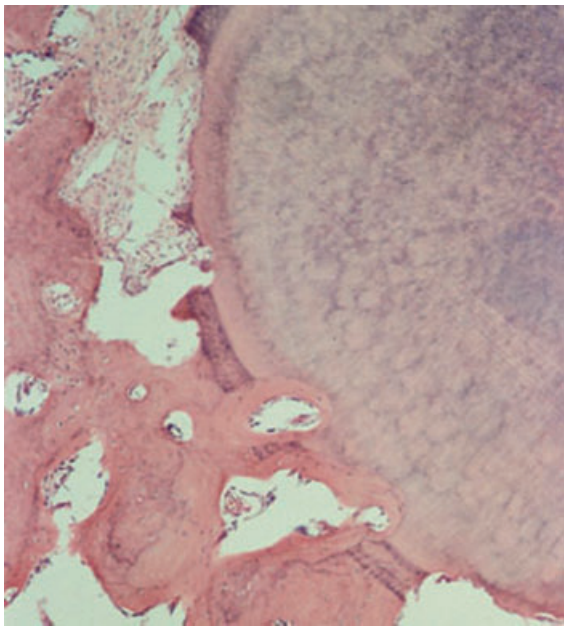

Fig. 6. Tooth submitted for orthodontic traction performed 7 days after intrusive luxation with replacement resorption (HE-100×). Arrows indicating repair of the radicular surface with formation of bone tissue.

Turley et al. (1) and Turley et al. (13) also recommended the immediate application of orthodontic force for repositioning of the teeth that suffered intrusive luxation, as in their observations, the replacement resorption was a frequent outcome, in which the traction was initiated 2–14 days after trauma. Furthermore, the authors cited, alerted the need of verification of the mobility degree of the teeth before beginning the orthodontic procedure. In the anchorage elements, areas of superficial radicular resorption restricted to cementum or invading the dentin surface in the middle and apical thirds were observed. The counter-lateral forces these teeth received during the orthodontic traction might have provoked a slight movement of intrusion and/or axial inclination which unleashed these peri-apical reactions.

Conclusion

The histological alterations of the periodontium observed in the teeth of the dogs submitted for intrusive luxation, allowed the conclusion that when appropriate treatment was not applied after intrusive luxation, extensive inflammatory reaction occurred, which resulted in the progressive degeneration of the structures that make up the periodontal ligament. The repositioning of the tooth by orthodontic extrusion, practiced right after the intrusive luxation, concomitant to the endodontic treatment, originated a smaller frequency of replacement resorption. This phenomenon may have occurred because of the periodontal injury caused by trauma. The endodontic treatment was primordial in the first 2 weeks after intrusive luxation because pulpar necrosis occurred in all teeth and may end up leading to severe pathological events in the sustentation periodontium.

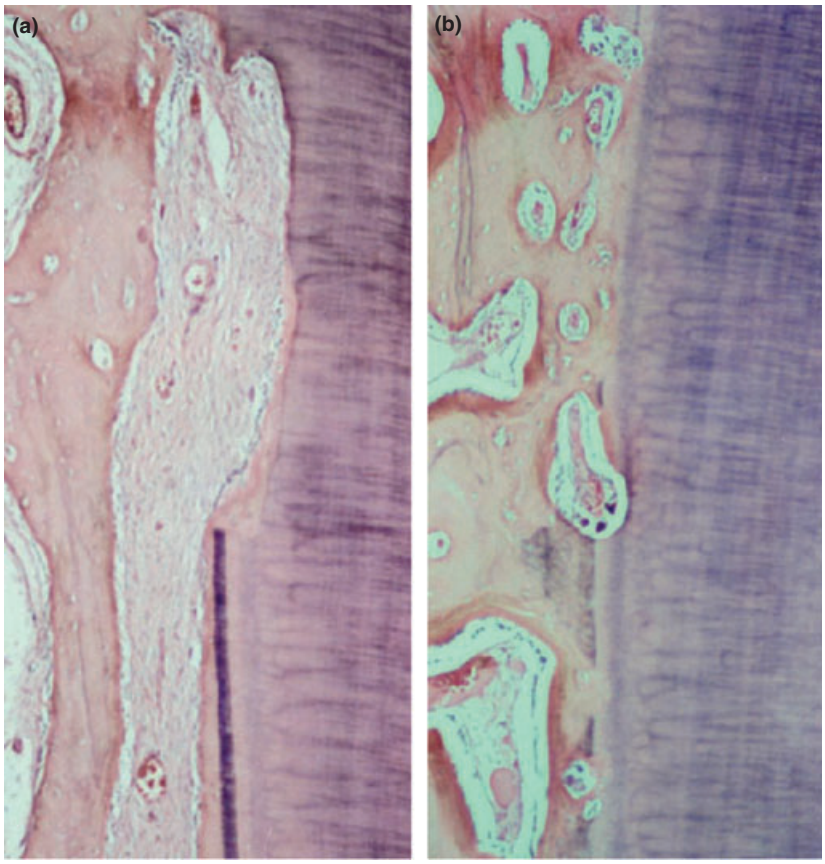

Fig. 7. Specimen that did not respond to orthodontic traction, 7 days after intrusive luxation. (a) Radicular resorption on the cervical third and (b), intimate relation between dental structure and bone.

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