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Effect of crown fracture on the surrounding periodontium

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Abstract – Clinical and histological alterations were analyzed in the periodontium of dog's teeth that had been submitted to crown fracture. To reach the long axis of the tooth, an impact device was applied to eight teeth of four adult dogs to produce trauma. Crown fractures involving the enamel and dentin, with or without pulpar exposure and without dislocation, mobility or gingival bleeding were analyzed within the post-trauma periods of 30 min, 1, 3, and 7 days. The force of impact that resulted in coronary fracture, although dissipated at the time of fracture, reverberated in the surrounding periodontium and may generate not only light histological alterations with a rapid re-establishment of the tissues, but also an intense inflammatory condition required as long as 7 days to clear up. The gravity of these inflammatory reactions unleashed in these teeth's periapical tissues depends on the absorption of impact by the periodontal structures and the individual susceptibility of each organism.

According to the World Health Organization (1) (WHO), crown fractures are classified as enamel fractures, crown/dentin fractures with and without pulpar involvement. The prevalence of permanent dentition trauma is high. Generally speaking, one in every two children aged 14 years has suffered some type of dental injury. Crown fracture is the most common type of dental trauma (2).

The force released upon the tooth, during the traumatic event may be dissipated when crown fracture occurs. However, part of this impact energy is absorbed by the periodontal structures, which may leave this tooth vulnerable to additional damage. The aim of this study is to evaluate the histological effect on the surrounding periodontium after trauma resulting in crown fracture.

Material and methods

A study was conducted on the clinical and histological aspects of the surrounding periodontium of the anterior-superior teeth of four dogs aged between 12 and 24 months, corresponding to the age of a young adult of the species *Canis familiaris* of undefined breed. Their teeth were submitted to dental traumatism on the long axis.

The animals were sent for scratching of the dental calculus followed by sensible prophylaxis. Periapical X-rays, pre and post-trauma were taken according to the bicentric technique with the aid of a radiographic positioner. Under the effect of deep anesthesia, the animals were positioned with their backs to the surgical table and their heads propped up and immobilized. The trauma was performed with the help of an impact device developed by the Department of Mechanical Trials of the Military Engineering Institute (Fig. 1). The device was activated when maximum compression of the spring was reached. The device was mortised in the selected tooth to suffer the trauma, perpendicular to its long axis and reached it with impact energy of 1326 J.

The teeth which sustained crown fracture were observed for 30 min, 1, 3, and 7 days after the event to verify the extent of the injury on the surrounding periodontium and monitor its re-establishment. The animals were sacrificed and longitudinal cuts in relation to the teeth's long axis were made and stained with hematoxylin and eosin.

The microscope used to analyse the tissue alterations was Leitz Wetlar ERGOLUX AMC (ERGOLUX, Austin, TX, USA) with 3 objectives generic 4×/0.1, 10×/0.25, 40×/10.65.

Results

Crown fractures occurred as a result of the trauma, involving enamel and dentin with or without pulpar exposure, but there were no instances of dislocation, mobility or gingival bleeding. Where pulpar exposure occurred, this was followed by hemostasis and the sealing of the pulpar chamber with sterile cotton balls, zinc oxidem, and eugenol. After 30 min, the teeth sustaining crown fractures without complications exhibited areas of narrow periodontal ligament in the medium

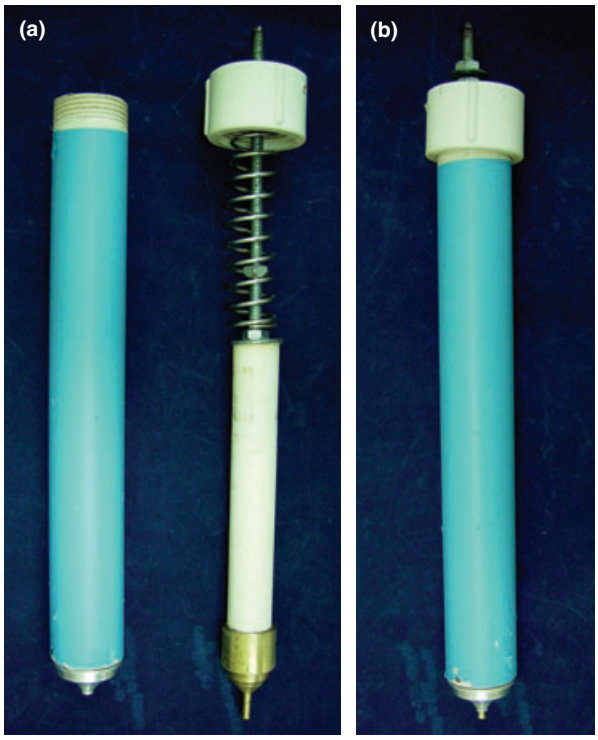

Fig. 1. Device that promotes the intrusive luxation. The activation was made by compression of the spring.

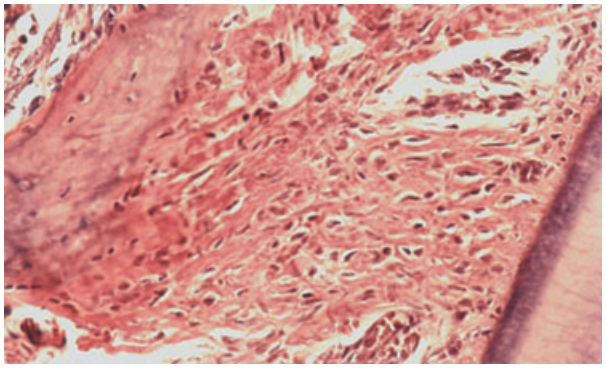

Fig. 2. Sustentation periodontium 30 min after crown fracture without pulpar involvement. Middle third of the distal surface compression of oblique fibers and redness.

and apical thirds of the radicular surface with compression of the collagen fiber. A great number of blood vessels were noticed, which accounts for the redness observed in the area (Fig. 2).

First day after the trauma, crown fracture with complications resulted, and in the absence of endodontic treatment, the medium and apical thirds displayed a significant narrowing of the periodontal ligament with numerous blood vessels exhibiting margined red blood cells (Fig. 3). On the third and seventh day following the trauma, distinct scenarios of tissular response to coronary fraction without pulpar exposure could be observed. On the third day, the narrowing of the periodontal ligament revealed compressed collagen fibers

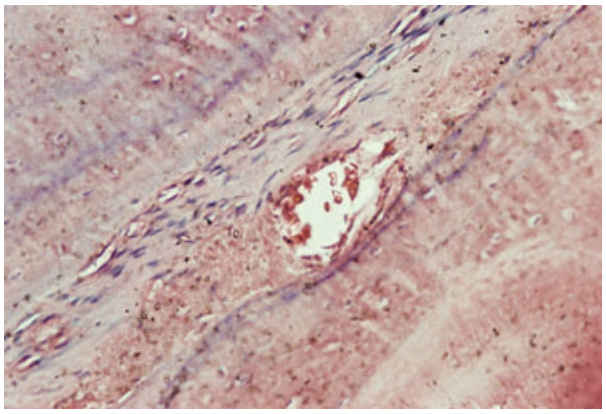

Fig. 3. Sustentation periodontium 1 day after crown fracture with pulpar involvement and margining of red blood cells in the interior of blood vessel.

arranged almost in parallel to the long axis of the tooth with the presence of fibroblasts. The blood vessels presented extravasation of red blood cells, which characterizes a mild hemorrhage, close to the alveolar bone (Fig. 4a). On the seventh day after the trauma, the tissues showed signs of recovering, the periodontal ligament exhibited high cellularity with the presence of

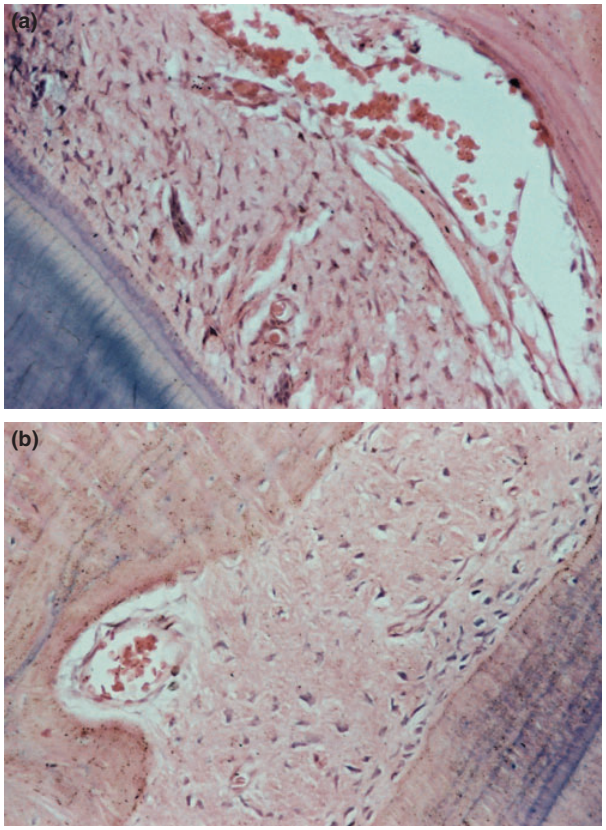

Fig. 4. Sustentation periodontium exhibits mild inflammatory reaction, 3–7 days after crown fracture. In (a), red blood cells flowing out of the vessel. In B, characteristics of normality, on the middle third of the distal surface.

Malassez epithelial remains and fibroblasts dispersed along the collagen fiber which displayed a normal arrangement. Some regions showed hialynized blood vessels and other areas were seen to contain red blood cells, which is consistent with normal blood flow. The radicular surface was anatomically normal and the alveolar bone's cortical region remained untouched (Fig. 4b).

In the specimens where the re-establishment of the periodontium was slow to take place, a similar scenario could be observed on the third and seventh day. The presence of inflammatory infiltrate was observed contiguous to areas of bone resorption with osteoclasts in Howship's lacunae and blood vessels, which were in most cases empty or with margined red blood cells (Fig. 5).

Discussion and conclusions

Comparisons between human alveolar bone and that of animals such as dogs and primates reveal that the alveolar bone in animals is denser regardless of age. The high density of the bone results from the filling up of the medullar spaces, which lead to more extensive areas of hialynization resulting in slower dental movement (3). Because of the existing differences, the tissular alterations observed in the sustentation periodontium of the animals used in the research were confronted with equivalent areas in control animals utilized in a previous study (4), and whose characteristics reveal this species' pattern of normality.

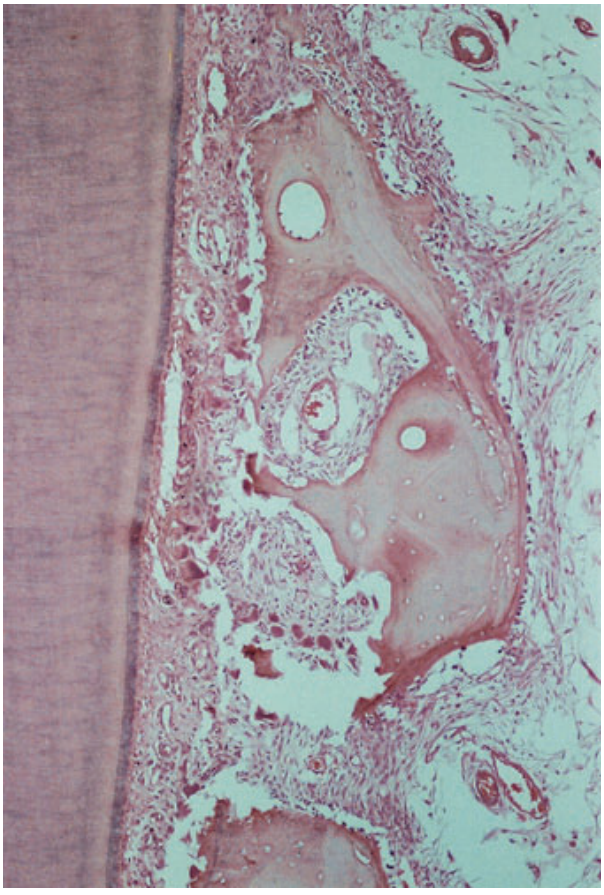

Fig. 5. Severe inflammatory reaction on the surrounding periodontium seven days after crown fracture.

The standardization of the trauma was established by the direction and intensity of impact. The diversity of responses of the structures comprising the sustentation periodontium to the instituted dental traumatism may be a result of either each organism's individual response determined by their susceptibility (5), or of the absorption of the force of impact by these structures (6).

After the application of the impact, the occurrence of crown fractures involving enamel and dentin, with or without pulpar involvement, and whose dislocation had not been detected during the clinical evaluation. Snawder (7) believes that the force released upon the tooth during the traumatic event may be dissipated when crown or root fracture occurs. If no fraction was found, this indicates that the tooth and the periodontal structures absorbed the energy of the impact.

However, in the histological analysis, one can notice that part of the resultant energy from the impact unleashed an inflammatory reaction during the first 30 min which was characterized by vascular dilation and hyperemia, which was also described by Gottrup & Andreasen (8) as the first tissular response to external aggression.

Explicit narrowing of the periodontal ligament occurred in teeth with crown fracture that did not exhibit clinical signs of dislocation, where one could notice the evolution of the inflammatory process 1 day after the trauma. In the blood vessels, there was margining of red blood cells. Some blood vessels were seen to be undergoing a degenerative process because of the interruption of local circulation. This shows great similarity to the reactions observed on the pressure side during the orthodontic movement stimulated by excessive forces (3,9,10).

On the third and seventh day following the trauma which resulted in crown fracture, one could observe a distinctive scenario of tissular response. There were specimens that revealed an almost complete re-establishment on the surrounding periodontium with collagen fiber that stretched from the cementum surface to the alveolar bone with an arrangement similar to that of a normal periodontal ligament, as well as the presence of active fibroblasts and blood vessels with red blood cells in their interior, matching Stuani's (4) description of control teeth. Other teeth exhibited areas with the presence of inflammatory infiltrate, where the mononuclear cells had promoted the removal of the periodontal ligament that suffered necrosis, and the absorption of the alveolar bone wall contributed to the relief of pressure, thus making structural repair possible. This, in turn was consistent with the scenario depicted by Brudvik & Rygh (11), albeit in a slower fashion. The differences in tissular responses might be related to the absorption of impact by the periodontal structures and to the extent and intensity of the damage to the periodontal ligament.

The degree of the reactions found makes it possible to suggest that the force of impact that resulted in crown

fracture, although dissipated in the moment of fracture, reverberates in the sustentation periodontium and may generate not only mild histological alterations with a rapid re-establishment of the tissues, but also an intense inflammatory condition which requires a period of time greater than 7 days to clear up.

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