Contact Microradiographic Analysis of Feline Tooth Resorptive Lesions

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ABSTRACT. Feline tooth resorptive lesions were studied using contact microradiographic analysis of ground sections. Contact microdiagram films were developed with a PIAS-imaging device, and decalcification patterns were evaluated, revealing a clear boundary between normal tissue and the resorptive area, which was different from the image of dental caries in humans. By contrasting analysis, decalcification signs appearing in human caries were not observed in feline resorptive lesions.—KEY WORDS: contact microradiogram, feline tooth resorption, Howship's lacunae.

Unlike caries, multinucleated giant cells are shown to play a major role in resorptive lesions of teeth [1, 3, 4]. Although high incidences of feline tooth resorptive lesions (FTRL) have been documented [5, 8, 9], histopathological studies have yet to be attempted. Caries in cats are hitherto non-existent. In this note, FTRL were thus compared with caries in human teeth (used on a comparative basis) using intraoral contact microradiography [6, 7].

Thirty-three mongrel cats of both sexes (ages: 1–8 years) were diagnosed to have resorptive lesions as manifested by intraoral dental radiography. From the radiolucency of these cases, only 10 pieces were successfully extracted intact. Because of difficulty in maintaining vertical parallelity between the film sheet and dental axis during X-ray examination, a bisecting angle technique was employed for diagnostic screening, and radiography was performed at 70 kVp, 6 mAs and FFD 20 cm. A nonscreen type of dental film (Junior; Hanshin Technical Lab., Hyogo) was used.

After fixation in 10% formalin, the extracted teeth were dehydrated in increasing concentrations of acetone prior to embedding in a polyester resin (RIGOLAC, Nissin EM, Tokyo). Specimens were first sectioned longitudinally into two halves. From the first half, serial ground specimens (200–300 μm thick) were prepared with a diamond disc (ISOMET, Buehler Manuf., Lake Bluff). Medio-distal sections, 100 μm thick, were then prepared from these halves and thereafter ground with a grindstone [1]. Finally, the ground serial sections were subjected to contact microphotography on a high-resolution film (Kodak SO-343) using a microscopic soft X-ray apparatus (SOFRON SRO-M40, Soken, Tokyo) at 15 kVp and 3 mAs for 42 min. Similarly, a caries-inflicted tooth of a male patient (22 years of age) was treated likewise, and used as a reference for comparison.

The second halves of the specimens were immersed in a high-speed decalcification liquid according to the Plank Rychlo method [2] and embedded in celluloid. Five-μm thick buccolingual sections were prepared and stained with hematoxylin and eosin for light microscopy.

Microradiographic evaluation of the ground sections was based on brightness inputs with the personal imaging analysis system (PIAS; LA-525, Osaka). Brightness intensity was categorized into ascending scores for various...

Fig. 1. Light microscopy of a feline tooth with resorptive lesions. The bucco-lingual section of the resorptive lesion depicts numerous odontoclasts (A) distributed regularly along a resorptive boundary (B) at the edge of the Howship's lacunae (C) in dentine (D). Resorptions (E) were of immature granulation tissues with infiltrated odontoclast and capillary vessels (H&E stain × 300).

Fig. 2. Contact microradiogram of resorptive lesion in a feline tooth showing distinctly clear contrast between Howship's lacunae (air) and dentine (bone) without caries-derived decalcified lesions. Abnormalities are not observed in dentine and dentinal tubules except for the resorptive cavity.
Fig. 3. Contact microradiogram of resorptive lesions in a feline tooth showing a bucco-lingual section of distal root region along the central axis of the buccal side with a resorptive cavity 2.1 mm in maximum diameter (A), and the absence of caries by PIAS-imaging analysis (B), as well as analysis (C) and histogram (D) of B (white square frame) portrayed by 3D-mapping.
Fig. 4. Contact microradiogram of a medio-distal section of the enamel of a human tooth (used on a comparative basis) showing gradual changes in calcification intensity on the superficial caries of the dentine region (A), and its PIAS-image analysis indicating gradual demineralization and from the lesion to dentine tissues (B), as well as analysis (C) and histogram (D) of B (white square frame) portrayed by 3D-mapping.
colours from 0 (black) to 225 (white), and a total range of 16-colour scores for contrasting brightness intensity was applied. For instance, brightness scores of 64 to 95 were interpreted as red. Moreover, projection was made with a 3-dimensional brightness contrasting profile (3D mapping) of the area surrounded by the white frame as well as another one-dimensional histogram corresponding to the white demarcation region.

In this study, 20 of the 34 X-ray identified FTRL cases before extraction were located at subgingival sites, and the remaining 14 occurred at the subgingival and buccal sides of teeth without any significant signs of the root lesions that expanded extensively within the teeth.

By light microscopy, a majority of the bucco-lingual sections revealed resorptive lesions with small and externally invisible cavities, which originated from the subgingival site of the dental neck and expanded from within the affected tooth. The pulpal cavity was involved, and the dentine was injured. In some cases, the bifurcation sites of dental roots were affected.

The brightness intensity of the boundary between the resorptive tissue and normal tissue was clearly depicted. By light microscopic examination, numerous odontoclasts were aligned along the resorption boundary at the edge of Howship's lacunae in the dentine. The dentinal tubules were regularly distributed, surrounding the resorptive cavity and manifesting neither structural defect nor decalcification as observed in human dental caries (Fig. 1). Immature granulation tissues were found to be responsible for resorption [1]. Further, contact microradiograms revealing post-resorptive retractions of gingiva were at the distal/proximal surface of bifurcated roots. In some cases, calcification in the cavities without any apparent structural changes were observed in the dentine/pulp boundary (Fig. 2).

As illustrated in Fig. 3A, contact microradiograms of the distal root of an extracted tooth showed FTRL with a maximum axis of 2.1 mm in the middle part of buccal side of the distal root. Serial microradiographic sections of this tooth, however, revealed no injuries at the profound dental pulp. Decalcification and calcification were found in dentinal tubules characteristic of dental caries. From these pathological findings, FTRL seemed to differ greatly from human dental caries (Fig. 4A).

On PIAS-imaging analysis, the dentine portrayed an image from dark green to eventually bright yellow colours, whereas the enamel white showed a maximum absorption of 255. The resorptive (Fig. 3B) and caries (Fig. 4B) cavities were expressed as dark shadows. The calcification intensity could also be visualized using a scale of 16 grades for colour contrasting, although evaluation by either apatite conversion or the aluminium sheet step-wedge method was not possible. For comparing dentine calcification of cats and human, the ground sections should be 100 μm in thickness. In contrast to dentine in the vicinity of dental caries cavities, where dark colour changed gradually into blue, red, magenta or eventually into green, FTRL showed a yellow pitched to dark colour without any intermittent interference. Thus, calcification intensity from the resorptive lesion to the dentine changed abruptly and promptly, suggesting that the changes did not result from acidification. A cliff-like steep shadow with such sudden changes in FTRL could be illustrated on 3D-mapping and histogram portrays (Fig. 3C and 3D), but not in caries where the change was gradual (Fig. 4C and 4D).

Dental lesions may be attributed to caries, resorptions or fractures. A previous study [1] has indicated the absence of decalcification in pathologically induced feline resorative lesions of permanent teeth. However, for discriminating lesions inflicted by caries from those affected by resorption, the intensity of dentine calcification manifested by PIAS imaging on contact radiomicro-radiograms would be a prerequisite in the field of pathology. The present study was focused on differences between the distribution pattern of calcification in FTRL and dental caries.

Based on the image of extremely thin ground sections, the contact microradiogram at relatively low voltage was able to distinguish minute differences in the progression and intensity of calcification in the enamel and dentine between FTRL and dental caries. By colour contrasting analysis, decalcification signs appearing in human caries were not observed in FTRL. The contact microradiogram might serve as a reliable method in the diagnosis of FTRL.

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REFERENCES