

Effect of Bony Ankylosis in Immature Permanent Teeth on Tooth Eruption

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Introduction

In the clinical setting of pediatric dentistry, a trend of increasing number of children presenting with traumatic injury of the teeth is seen recently. Trauma to the permanent teeth occurs most commonly in the maxillary anterior teeth during the early half of the school ages, and the injured teeth are immature permanent teeth in the middle of eruption. During this period, if the tooth is avulsed due to trauma, replantation is attempted as far as possible. However, the periodontal membrane of the detached tooth is rarely well preserved, and the outcome is a high rate of bony ankylosis¹⁾. The occurrence of bony ankylosis during the developmental stage not only impairs normal eruption of the tooth²⁾, but is also expected to have great impact on the dentition, occlusion and jaw development.

For the purpose of elucidating the effect of bony ankylosis in immature permanent teeth on tooth eruption, we extracted the maxillary anterior teeth from young dogs, immersed them in fluoride and replanted the teeth to induce bony ankylosis, and examined the changes histopathologically.

Methods

Healthy young beagles around 5 months of age were used. All treatments were conducted according to the guidelines on animal experimentation of the Nippon Dental University. The upper right first incisor (URI1) and second incisor (URI2) were used in the experiment. Preoperative radiographs showed that the root apex was almost completed in URI1 while root formation was incomplete in URI2.

Under general anesthesia, the experimental tooth was completely luxated, and a knife was used to completely detach the periodontal membrane that was adhered to the root. The pulp cavity was opened from the lingual side of the crown, and the pulp was extirpated. The tooth was immersed in sodium fluoride for 20 minutes. Then, the root canal of the detached tooth was filled with a calcium hydroxide dressing and then temporarily sealed with glass ionomer cement.

The treated teeth were replanted back into the respective alveolar sockets. Physiological splinting was performed using orthodontic power chain and composite resin. The splinting period was 3 weeks. The contralateral teeth with the same nomenclature did not undergo replantation and were used as control.

As a time marker for hard tissue, tetracycline (20 mg/kg) was injected subcutaneously (s.c.) during replantation and 1 week after replantation, and calcein (8 mg/kg) was injected s.c. 2 weeks and 1 week before the maxilla was harvested.

The dogs were reared for 3 to 9 weeks. After removing the maxilla bone, Micro-focus X ray CT scan was conducted. Then

the maxilla bone was embedded as a resin block. Consecutive thin slices were cut along a plane vertical to the axis of the incisors both on the left and right sides. Then non-calcified consecutive ground sections approximately 100 µm in thickness were prepared along the horizontal plane. The consecutive sections were examined by microradiography, and histopathological studies using fluorescent microscopy and other methods.

Results

Bony ankylosis was observed in all the replanted teeth. Bony ankylosis was accompanied by progressive resorption of dentine of the root in some teeth and not accompanied by root resorption in others (Fig. 1).

At 3 weeks after replantation, bone remodeling was greater on the experimental side than on the control side, and was more prominent at the root apex than at the dental neck.

In the experimental teeth, the height at the top of the alveolar bone was reduced, and the width of the inter-alveolar septal region was increased compared to the control teeth.

On the experimental side, the alveolar bone near the labial dental neck showed concavity compared to the control teeth, indicating delayed growth of the labial alveolar bone due to bony ankylosis.

Bone formation in the inter-alveolar septal region of the experimental tooth showed a transition toward the surface of the root undergoing progressive bony ankylosis, and the central portion was low calcified density.

In the experimental tooth, the effect of bony ankylosis did not extend to the opposite side of the median palatine suture.

Discussion

In this study, we hypothesized that bony ankylosis occurs in traumatized tooth occurring during the early half of the school ages, and conducted histological observation of the effects of bony ankylosis on dentition and jaw development in a young canine model.

Immature permanent teeth are in the process of eruption, and internal remodeling of the alveolar bone will ultimately determine the dentition and occlusion. Tooth eruption is closely related to the growth of the alveolar bone, and the periodontal membrane that connects the tooth and the alveolar bone plays an important role. Our results suggest that bony ankylosis as a result of loss of the periodontal membrane prevents normal eruption and interferes with normal internal remodeling of the surrounding alveolar bone.

In conclusion, bony ankylosis occurring in immature permanent teeth inhibits normal bone formation of the jaw bone and interferes with normal tooth eruption.

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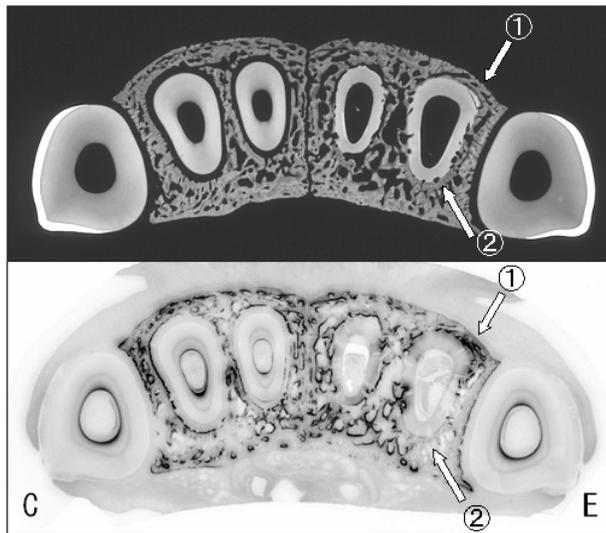


Fig. 1. Micro-radiogram (upper panel) and calcein labeling fluorescent analysis (lower panel) of a dog at 9 weeks after implantation.

In the experimental tooth URI2, bony ankylosis progresses in the labial distal angle (), but bony ankylosis has arrested in the palatal distal angle ().