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Effects of Fluoride on Deciduous Teeth Resorption of Young Rabbits

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Fluoride is essential in the diet and is thought to be required for normal dental and skeletal growth (Mertz 1981). During recent years, fluoride has been increasingly used as a drug not only for prevention of dental caries but also in the treatment of various bone diseases (Newbrun 1980; Budden et al. 1988). This has led to growing interest in the pharmcologic properties of fluoride in man. The effect of fluoride on the histological structure of developing dental tissue of experimental animals was first reported by Bergara (1929). Schour and Smith (1934) found that the subcutaneous injection of sodium fluoride into rats caused and alteration in enamel formation 24 hours after the injection was given. Since then, a number of studies of similar nature have been reported (Kruger 1967, 1970; Mornstad and Hammarstrom 1978; Nordlund and Lindskog 1986).

Most of these published studies have dealt with the effects on the developing hard tissues of large doses of fluoride administered by injection. No attention has been devoted to the response of the deciduous tooth resorption. In the present investigation the effects of fluoride on the deciduous tooth resorption of rabbits is studied.

MATERIALS AND METHODS

12 young, 7 days old New Zealand white rabbits (Oryctolagus cuniculus) were used. The upper maxillary posterior deciduous incisors is the experimental model of choice for studying root resorption because this tooth in single root and to the root resorption similarity of the human deciduous tooth (Arita 1984). They were injected intra-

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peritoneally with 0.01ml/g body wt. of a 0.07% aqeuous solution of sodium fluoride twice daily at 8:00 a.m. and 1:00 p.m.. The sodium fluoride solution was sterilized by filtration through a type HA millipore membrane. All solutions were stored at 10 degrees C. in polyethylene flasks when not used.

The dose of 7mg F/kg body wt. was known to alter the morphology of teeth and to produce changes in the enamel of teeth without affecting the general growth rate of the animals (Kruger 1967). The administration of two doses

each day was an attempt to prolong the effect of treatment, as fluoride is rapidly removed from the circulation (Wallace-Durbin 1954). Littermates served as controls, the sodium fluoride being replaced by sterile physiological saline (0.9% aqueous solution of sodium chloride).

The rabbits were sacrificed with ether inhalation at 13th day after the last injection. Immediately after decapitation, the skin and soft tissue were removed. The maxilla of each animal were separated through the palatal suture and both maxillary incisors with the surrounding tissues were fixed in 10 % neutral formalin for 48 hours followed by decalcification in Plank Rychlo's solution for one week. The specimens were embedding in paraffin wax and serially sectioned at 7um. The sections were routinely stained with hematoxylin and eosin. The results were recorded photomicrographically.

RESULTS AND DISCUSSION

The diphyodent nature of the rabbits dentition makes this animal an ideal subject for histologic studies of deciduous tooth resorption and exfoliation (Arita 1984). This studies on the maxillary deciduous incisor teeth can feasibly be extended to include observations on resorption due to the ease of making direct measurements.

In control rabbits, with the maxillary deciduous posterior incisors, root resorption appeared not only in the labial side, but also in the lingual side of the deciduous root were observed in Figure 1 and 2. In figure 3, there are many odontoclasts in resorption lacunae invading into root dentin.

Figure 1. Day 13 postnatal of control rabbit. Sagittal section showing the relationship between a deciduous maxillary posterior incisor with root resorption (arrow) and its successor which is undergoing amelogenesis (H.E., x 5).

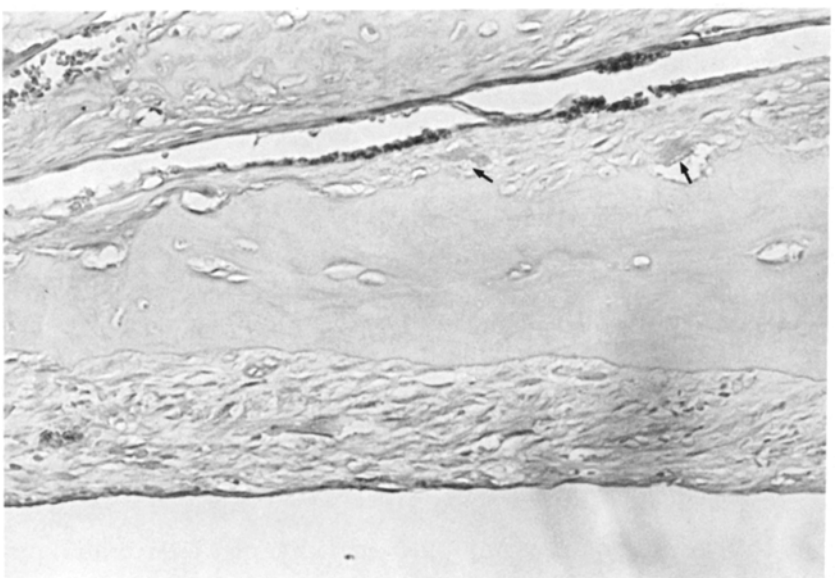

Figure 2. Higher magnification of Fig. 1, showing posterior incisor have been resorbed severely on the labial and lingual side. The resorption lacunae with odontoclasts on the labial side (arrow) have reached into dentin (H.E., x 30).

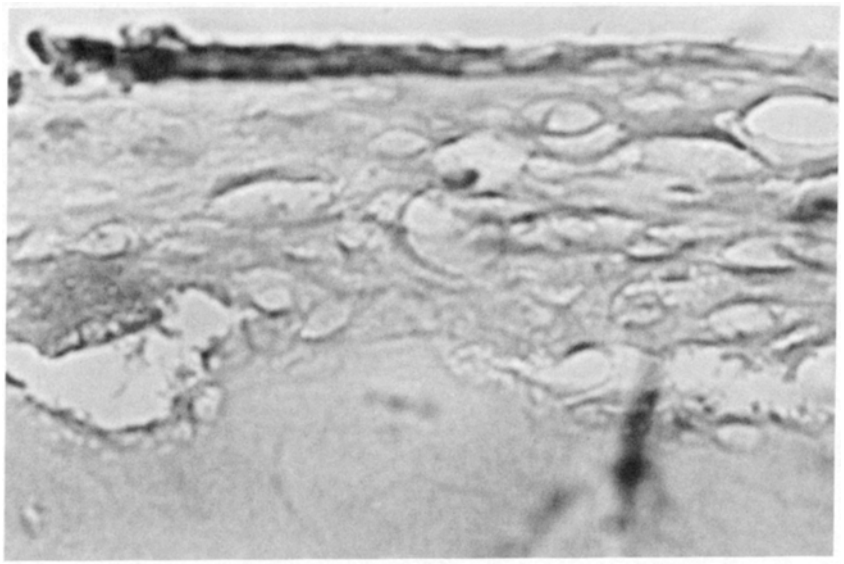

Figure 3. Higher magnification of Fig. 2, showing the resorption lacunae on the labial side of deciduous root has reached into the dentin. Odontoclasts have been separated from the resorption lacunae (H.E., x 200).

In exposed rabbits, the root resorption of the maxillary deciduous posterior incisors were almost at rest showing in figure 4 and 5.

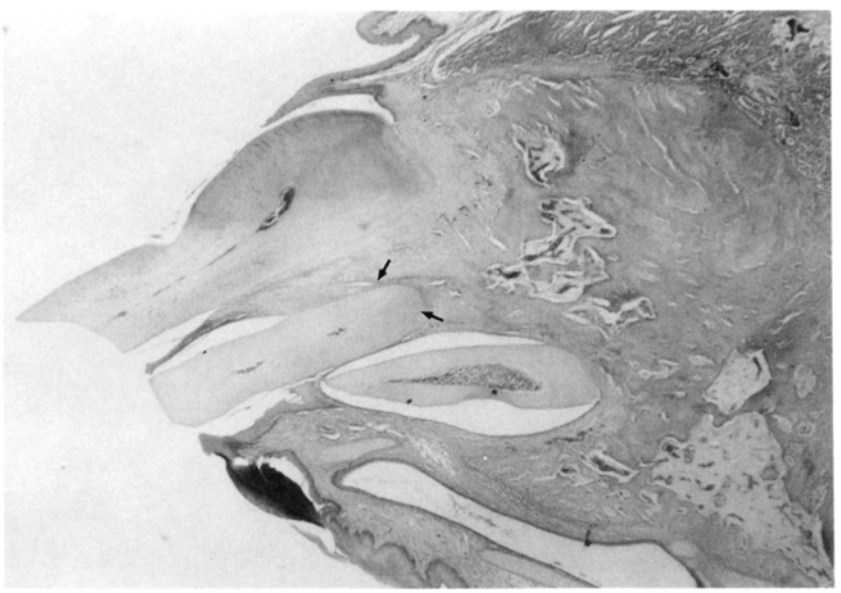

Figure 4. Day 13 postnatal of experiment rabbit. Sagittal section showing overall severe disturbance in root resorption of maxillary posterior incisor (arrow) (H.E. x 30).

Figure 5. Higher power viewed of Fig.4, showing no odontoclast or Howship's lacunae in root surface. Cessation of root resorption could be seen (H.E., x 30).

In figure 6, odontoclastic activity has ceased on the root surface, and reversal line in areas were then replace by cementoblasts-like cells.

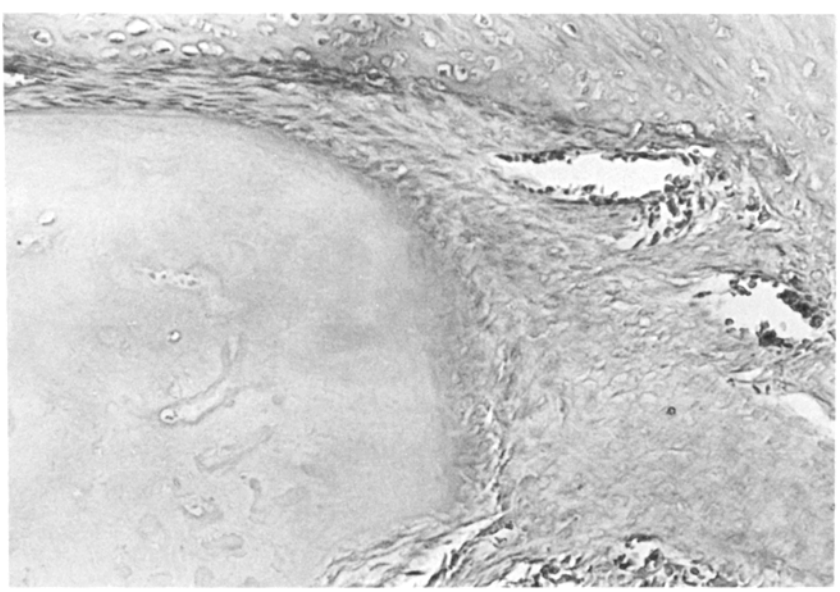

Figure 6. Higher power viewed of root surface in Fig. 5, showing the parts of root were surrounding by cementoblast-like cells. No odontoclast cell was present (H.E. x 50).

The results indicate that administration of 7mg F/kg of sodium fluoride markedly inhibited the appearance of odontoclasts, and retarded root resorption. The control group was not affected.

The literatures indicate that Fluoride intake is one of the best documented causes of disturbed enamel formation (Nordlund and Lindskog 1986). It is well know that high doses of fluoride can cause disturbances in secretory ameloblasts (Kruger 1967, 1970; Mornstad and Hammarstrom 1978) resulting in disturbed enamel formation.

Fluoride has been reported to inhibit in osteoclastic activity , thus decreasing bone resorption in vivo studies (Faccini et al. 1974, Hudson 1961). In vitro, bone resorption was inhibited by immersion for one minute in sodium fluoride (Goldhaber 1967). Treatment of avulsed teeth with fluoride prior to their replantation into the oral cavity has also been shown to inhibit resorption of cementum and dentin (Shulman et al. 1968; Bjorvatn and Massles 1971). The mechanism and the role of sodium fluoride to inhibit root resorption are still unclear. Theories most often encountered are 1) direct action of fluoride on bone, cementum and dentin to change hydroxapatite into fluorapatite which is most resistant to resorption process (Likins et al. 1963). 2) special inhibitary influence on the formation of the highly specialized cells responsible for the resorption osteoclasts, cementoclasts etc. (Hudson 1961).

The results of our studies suggest that fluoride will also inhibition of deciduous tooth resorption, because its interferes with odontoclastic activity. Hasselgren and Stromberg (1976) in their study showed activites of acid phosphatase in the multinucleated cells which are present in the lacunae of area undergoing dentin resorption. The actively resorbing odontoclast has a uniquely low intracellular pH (Freilich 1971). Penetration of cell membranes by the fluoride ion is facilitated by a low pH (Whittford et al. 1977). It thus follows that the actively-resorbing odontoclast is most likely easily penetrated by fluoride ions. Consequently, a higher intracellular level of fluoride may be accumulated leading to toxic effects on various enzyme systems in the odontoclast levels which may even have been lethal to the cells. Through the antienzymic effect the odontoclasts may

inhabit after administration of sodium fluoride. This may explain the drop in odontoclast activity.

Despite the short experimental period of these animals, it appears that high dose of fluoride may impair the activity of odontoclast cells, therby slowing down the root resorption process. Although from previous evidence repeated doses of 7mg F/kg body weight would not affect the gain in weight of young rats (Kruger 1967), 7mgF/kg is a very toxic level of fluoride for the root resorption. Fluoride is now regarded as an essential element for mammals, but also possesses a powful toxic potential when administered in large dose. Further research in this area would, thus appear to be of value in order to find out which dose of sodium fluoride is required for this effect.

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