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RADIOSODIUM INCORPORATION IN DEVELOPING TEETH OF DOG AND RAT STUDIED BY MEANS OF AUTORADIOGRAPHY

by

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Recently it was found by *Huggert, Odeblad, Söremark, & Ullberg* (1961) in an investigation with Na^{22} on mice, rats, and rabbits by means of impulse counting techniques and autoradiography that the highest uptake of radiosodium in the body occurs in the hard tissues.

These findings aroused our interest in a more detailed investigation concerning the uptake of radiosodium in developing teeth.

MATERIAL AND METHODS

The radioactive isotope Na^{22} used was supplied by the Isotope Division, Harwell. Na^{22} was used in the form of sodium chloride in isotonic solution. The present investigation was carried out on one rat 8 days old, and one dog about 24 hours old. The isotope solution was given in a single dose subcutaneously in the dorsal neck region.

Twenty-four hours after the injection the entire animal was rapidly frozen by immersion in a mixture of solid carbon dioxide and acetone at about —70°C. In a freeze room at —10°C the head was cut free. The specimen was mounted in ice on a microtome stage. Five micron thick sections were then taken using a sledge microtome, placed in the freeze room. To obtain whole sections, cellulose tape was carefully pressed on to the flat upper surface of the specimen block before cutting a section. The sections on the tape were freeze-dried for about 24 hours in the freeze room.

The sections were then dry-mounted on Ilford G 5 nuclear emulsion by means of minute amounts of egg-albumin glycerin. After exposure for about 2 weeks, the sections and emulsions were freed from the tape by immersion in xylene, whereupon developing and fixing as well as staining followed. The sections in permanent contact with the emulsion were then mounted in Canada balsam.

The autoradiographic technique used in the present investigation was described in detail by *Ullberg* (1954 and 1958) and by *André* (1956).

RESULTS

Generally, the autoradiograms showed the highest uptake of Na^{22} in those parts of the teeth and bones which were under rapid mineralization.

In all tooth germs the uptake of Na^{22} in dentine was much higher than in enamel.

In dentine, the radiosodium was concentrated in a zone close to the predentine layer. This zone of Na^{22} uptake was more pronounced in the coronal dentine than in the root dentine where the distribution was more even. In the dentine forming the bottom of the pulp cavity, a high uptake of radiosodium was also observed. The predentine layer showed a low accumulation of radiosodium.

In rapidly calcifying teeth the main uptake of radiosodium in the enamel was found in a zone adjacent to the ameloblast layer.

In tooth germs not having reached a calcification stage (consequently being in the bud or cap stages), no accumulation of Na^{22} was found.

Analogously to the incorporation of radiosodium in the hard tissues of teeth under calcification, the highest accumulation of Na^{22} was found in the ossification zones of the bone. Thus, a high uptake of radiosodium could be seen in those parts of the alveolar bone that were under a rapid rebuilding process.

DISCUSSION

As sodium is known preferably to be extracellularily distributed it might be expected that only a small fraction of the sodium administered would appear in low-vascularized tissues like bone and teeth. However, sodium is more concentrated in these tissues than in soft tissues. *Bauer & Carlsson* (1955) found about one half of the body sodium to be located in the skeleton and of this skeletal sodium 20—50 per cent were found ascribable to the bone water. In the already mineralized areas of teeth, the uptake of radiosodium was several times higher in dentine than in enamel. It will be noted in this connection that enamel and dentine contain about similar total amounts of naturally occurring sodium, about 1 % according to a recent investigation by *Söremark & Samsahl* (1962) based upon radioactivation analysis on human teeth.

The present investigation shows some similarities in the exchange and incorporation pattern of Na^{22} in the teeth to that of some other elements, *e.g.* F^{18} (*Ericsson, Ullberg & Appelgren,* 1960), V^{48} (*Söremark, Ullberg & Appelgren,* 1962) and Ca^{45} (*Bélanger,* 1957).

SUMMARY

The distribution of subcutaneously injected radiosodium (Na^{22}) in developing teeth of a 24 hours old dog and an 8 days old rat has been investigated by means of microautoradiography.

The uptake of radiosodium was found to be much greater in dentine than in enamel. The highest concentration of Na^{22} in dentine was found in those parts that were under rapid mineralization. The principal dentinal incorporation occurred in a continuous zone close to the predentine layer. The predentine

layer showed a low accumulation of radiosodium. In teeth under rapid calcification, the main uptake of radiosodium in enamel was found in a zone adjacent to the ameloblast layer. In tooth germs in the bud and cap stages no accumulation of Na^{22} was found in the various structures.

RÉSUMÉ

INCORPORATION DE SODIUM DANS LES DENTS. ÉTUDE AUTORADIOGRAPHIQUE AVEC NA^{22} SUR CHIEN ET RATON

La distribution du radiosodium, sous-cutanément injecté, dans des dents en développement a été étudiée à l'aide de radiographie. Le chien était agé de 24 heures et le raton de 8 jours. L'incorporation de radiosodium était plus grand dans la dentine que dans l'émail. La plus grande concentration de Na^{22} dans la dentine était dans les structures à minéralisation rapide. L'incorporation dans la dentine formait une zone près de la couche de prédentine. Dans la prédentine l'incorporation de radiosodium était faible. Dans l'émail à calcification rapide l'incorporation principale était trouvée dans une zone attenante à la couche améloblastique. D'autre part, dans les dents encore non-minéralisées aucune accumulation de Na^{22} n'était trouvée dans les structures différentes.

ZUSAMMENFASSUNG

ABLAGERUNG VON RADIOAKTIVEM NATRIUM IN NICHT DURCHGEBROCHENEN ZÄHNEN EINES HUNDES UND EINER RATTE. EINE UNTERSUCHUNG MIT HILFE VON AUTORADIOGRAPHIE

Die Verteilung des subkutan injizierten radioaktiven Natriums (Na^{22}) in den Zahnanlagen eines 24 Stunden alten Hundes und einer 8 Tage alten Ratte ist mit Hilfe von Autoradiographie untersucht worden. Die Aufnahme von radioaktivem Natrium war viel grösser im Dentin als im Schmelz. Die höchste Konzentration von Na^{22} im Dentin wurde in Strukturen mit schneller Mineralisation gefunden. Im Dentin bildete die Aufnahmezone eine Schicht nahe der Prädentinzone. Die letztere zeigte eine geringe Aufnahme von radioaktivem Natrium. In Zähnen mit schneller

Mineralisierung wurde die hauptsächliche Aufnahme in einer Schicht unmittelbar unter den Ameloblasten gefunden. In noch nicht mineralisierten Zahnanlagen wurde keine Akkumulation von Na^{22} in den verschiedenen Strukturen gefunden.

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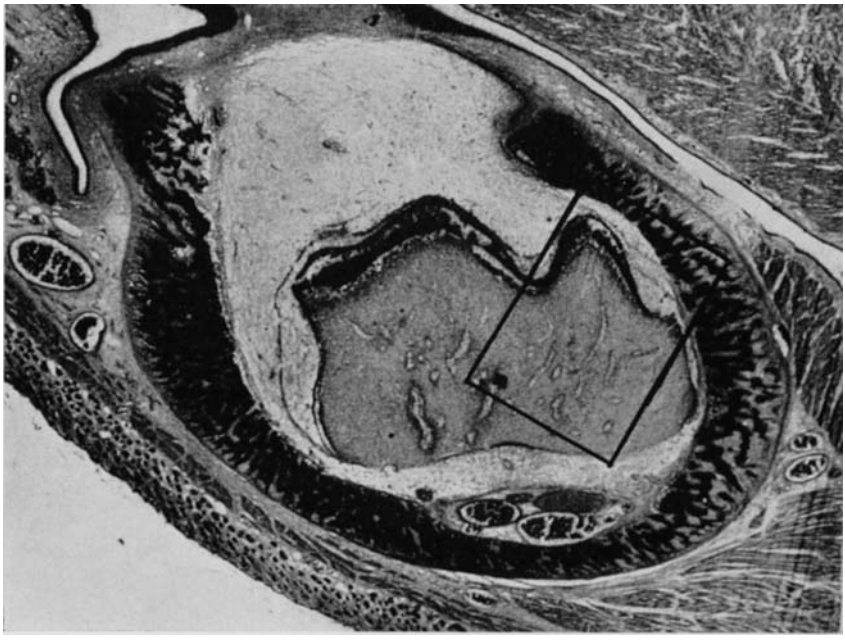

Fig. 1. First lower molar, unerupted, from a dog 24 hours old. Photograph of a haemalum-eosin stained section with adhering nuclear emulsion (40×). Black dots and areas show the uptake of Na^{22}. Note high uptake of Na^{22} in dentine and alveolar bone.

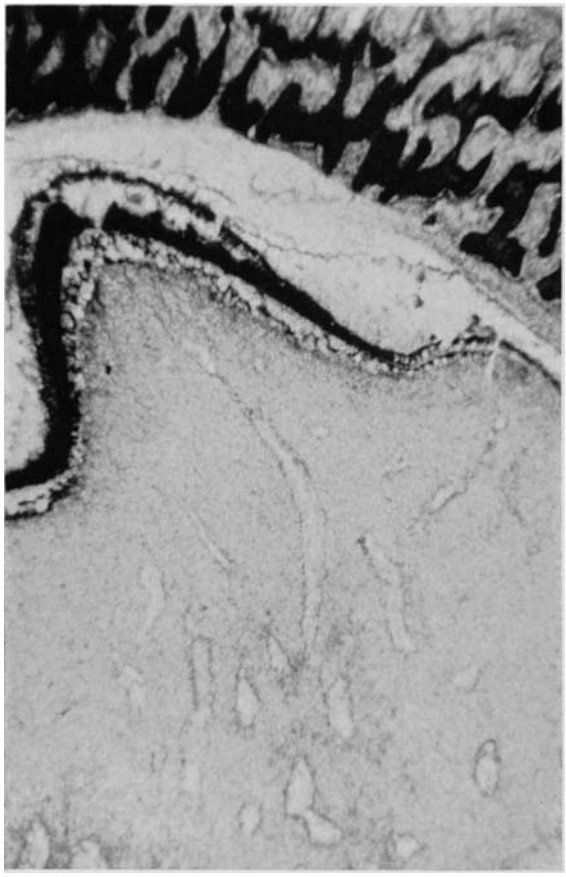

Fig. 2. Framed area from Fig. 1. High concentration of Na^{22} is visible in the dentine, in the enamel adjacent to the ameloblast layer, and in the jaw bone. (50×).

Fig. 3. Sagittal section through the nose and jaws of an 8-day-old rat with developing teeth in the upper and lower jaws. Photograph of a haemalum-eosin stained section with adhering emulsion. Note the high uptake of Na^{22} in the hard tissues, cartilage, hair follicles, and in the palatal and lingual surface epithelium. The concentration in the central nervous system is rather low. (7×).

Fig. 4.
Framed area from Fig. 3. Upper jaw with developing incisor. Colour photograph of stained section with adhering film. Note the great uptake of Na^{22} in the pulpal zone of the dentine and in the enamel zone adjacent to the ameloblast layer. (50×).