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TEETH AS INDICATORS OF BONE DENSITY*

by

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The worst obstacle in the roentgenologic estimation of the bone density is the non-mineralized structures surrounding the bone to be examined (*Virtama,* 1960). The teeth are the only parts of the skeleton not covered by soft parts. Therefore, they are theoretically in a very favourable position from the point of view of roentgenologic bone density estimations. The purpose of this study was to examine the possibilities of roentgenologic bone density estimations of teeth and try to find out whether teeth could be used as indicators of bone density of the entire skeleton.

MATERIAL AND METHODS

The material consisted of 38 second maxillary incisor teeth and 24 mandibular incisor teeth. In addition, the bone density of 15 mandibles and 18 mandibular incisor teeth belonging to these mandibles was determined. The material was obtained from the collections of the Department of Anatomy, University of Helsinki. For the determination of the density of teeth, a special device, recently described by *Reid & Halff* (1961), for direct estimation of density of small solids, was employed. Furthermore, the bone density of the teeth and the mandibles was determined as follows: the degreased bones were kept in an oven at a temperature of

* Aided by a grant from The Yrjö Jahnsson Foundation.

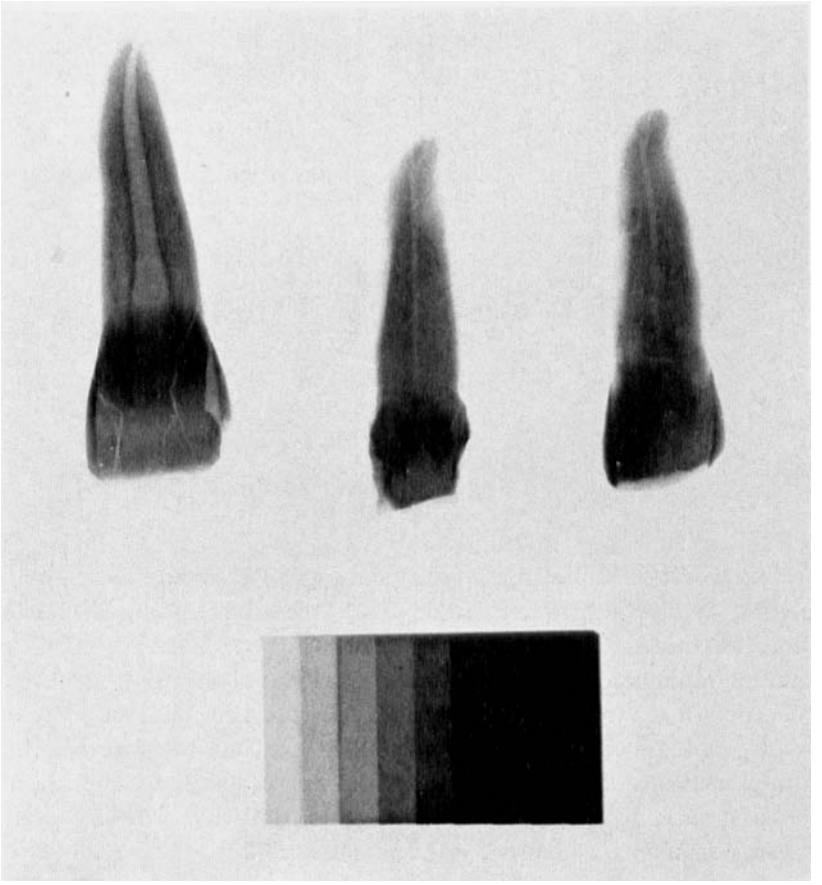

Fig. 1. The step-wedge and three roentgen images of the teeth used for densitometric reading.

60° C for two weeks. Then they were weighed with a Mettler B 6 balance. Their volume was determined pycnometrically using special pycnometers designed according to the size and shape of the bone in question. The dry weight divided by the volume was used as parameter of the actual bone density (*Telkkä et al.*, 1962).

The teeth were radiographed with a four-valve roentgen machine at 40 kV at a distance of one meter. The film used was Kodak Crystallex non-screen fine-grain film. A small aluminium step-wedge was used as a reference (Fig. 1). The films were developed in Kodak DX 80 developing solution, and were analyzed

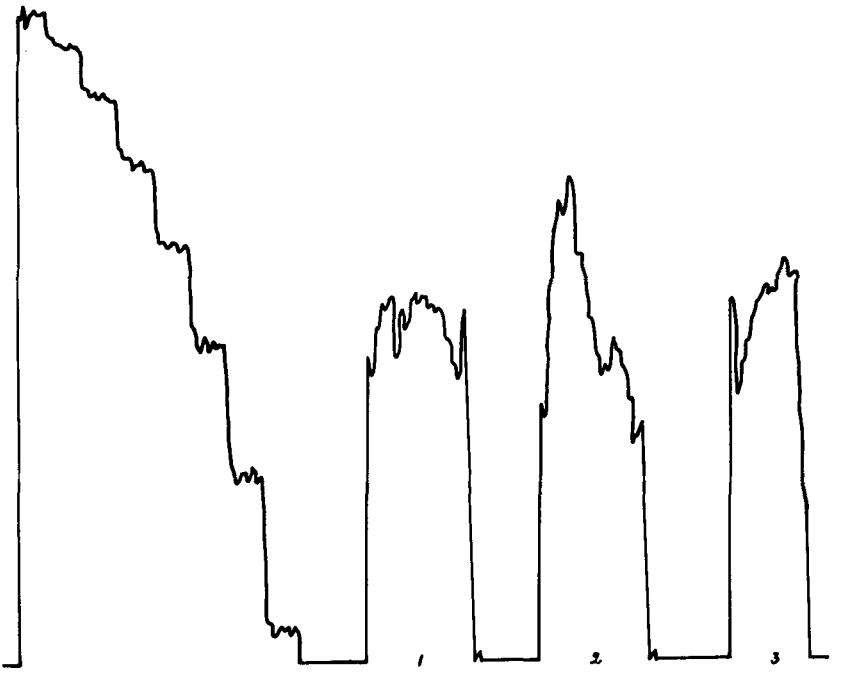

Fig. 2. The densitometric curve of the step-wedge (on the left) and curves obtained from three teeth.

with the aid of a Joyce & Loebl automatic recording densitometer. The measurements were made along the image of the step-wedge as well as along three tracing paths across the images of the teeth (Fig. 2). The thickness of the teeth at the level analyzed densitometrically was measured, and the density values expressed in thickness of aluminium were correspondingly corrected. Correlation of the density values and those obtained roentgenologically were compared according to the common principles of statistical analysis. The density values of the mandibles and the teeth extracted from them were treated in the same manner.

RESULTS AND DISCUSSION

Pieces of .001 inch thick Mylar film**) were fastened on the density estimated according to the method of *Reid & Halff* (1961) and the roentgenologically determined bone density of the second

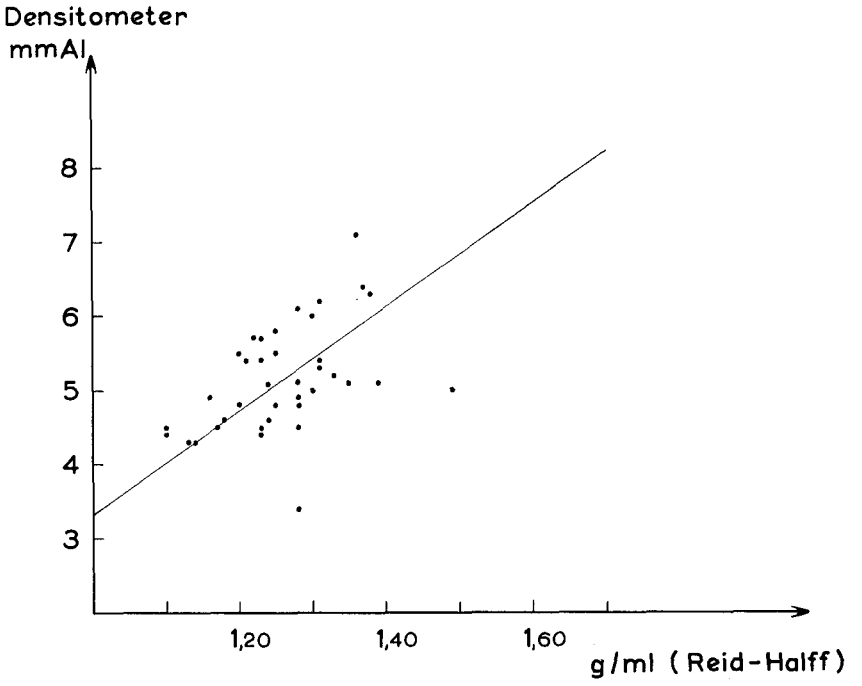

Fig. 3. The correlation between the densitometric reading and the bone density values obtained by the method of *Reid & Halff*. Second maxillary incisor teeth.

maxillary incisor teeth (Fig. 3). The regression equation was as follows,

$$y = 6.9\ x - 3.58, \qquad P < 0.001$$

where x is the density value obtained employing the method of *Reid & Halff* and y is the roentgenologically determined density. The same correlation between the different mandibular incisor teeth was as follows,

$$y = 9.3\ x - 6.26, \qquad P < 0.001 \qquad \text{(Fig. 4)}.$$

There was no significant correlation between the mandibles and the teeth belonging to them. The pycnometrically determined density of the teeth examined was about 2.1 g/ml and with the millet

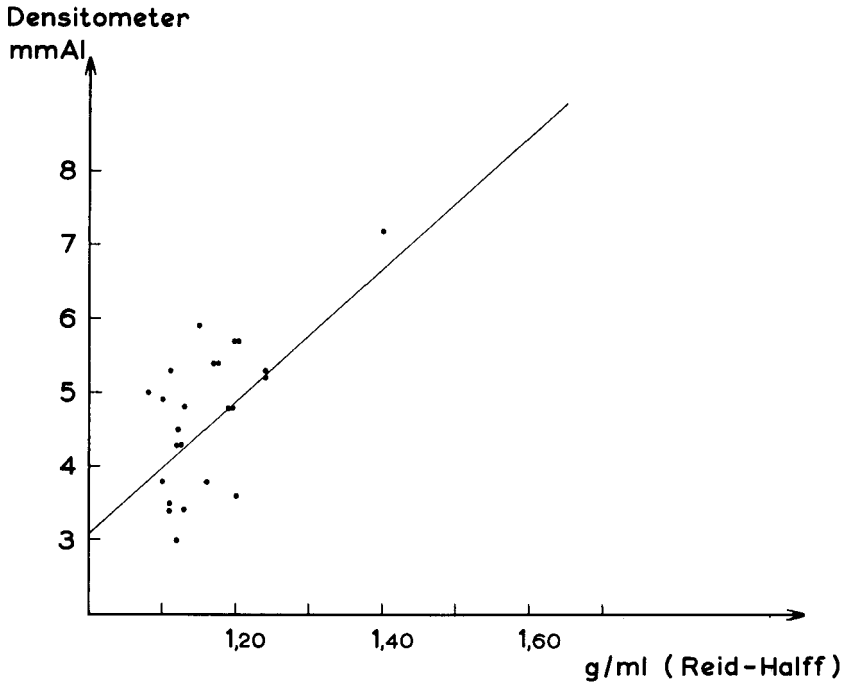

Fig. 4. The same correlation as in Fig. 3. Mandibular incisor teeth.

seed method (*Hopsu et al.*, 1961) the estimated density of the mandibles was about 1.2 g/ml.

As seen from the scatter diagrams (Figs. 3 and 4), variations in the bone densities of the teeth examined are relatively small. Moreover, they do not correspond to the variations of the bone densities of the mandibles. The change of the mineral content in the teeth seems to be rather low. The human teeth are apparently a relatively "dead" part of the skeleton and cannot be compared in activity with cancellous bone tissue which rather soon reacts, e.g., to calcium-free diet (*Virtama & Kallio,* 1961). Thus it is apparent that the teeth cannot be used as indicators of the mineralization stage of the whole skeleton and that their bone density does not even show the variations observed in the mandibles.

SUMMARY

The density of the teeth, which theoretically are in a favourable position for roentgenologic density estimation, was investigated. There was a significant correlation between the bone density values of the teeth obtained by the roentgenologic and physical methods employed. There was, however, no correlation between the mandibles and the teeth belonging to them. This seems to indicate that the bone density of the teeth cannot be used as an indicator of the mineralization stage of the entire skeleton.

RÉSUMÉ

LES DENTS COMME INDICATEURS DE LA DENSITÉ OSSEUSE

Les dents occupant théoriquement une position favorable pour l'estimation radiographique de leur densité, les auteurs ont fait l'étude de leur densité. Il existait une corrélation significative entre les valeurs de la densité osseuse des dents obtenues par les méthodes radiographiques et physiques employées. Il n'existait cependant pas de corrélation entre les mandibules et les dents leur appartenant. Ce fait semble indiquer que la densité osseuse des dents ne peut être utilisée comme indicateur du degré de minéralisation de squelette entier.

ZUSAMMENFASSUNG

ZÄHNE ALS INDIKATOREN DER KNOCHENDENSITÄT

Die Densität der Zähne, die sich theoretisch in günstiger Lage für die Bewertung der röntgenologischen Densität befinden, ist untersucht worden. Es bestand eine signifikante Korrelation zwischen den Werten der Knochendensität der Zähne bei Anwendung röntgenologischer und physikalischer Methoden. Dagegen hat sich keine Korrelation zwischen den Unterkiefern und den zu ihnen gehörenden Zähnen herausgeställt. Dies scheint zu erweisen, dass die Knochendensität der Zähne nicht als Indikator für das Mineralisationsstadium des gesamten Skelettes angewandt werden kann.

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