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## DENSITY AND MINERAL CONTENT OF HUMAN MANDIBLES

by

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### INTRODUCTION

The quantitative analysis of bone minerals by chemical methods is troublesome and time-consuming. *Telkkä et al.*, (1962) have shown that the dry weight of a bone can be used as an accurate estimate of the actual mineral content for small hand bones. This finding is of specific practical importance especially in examining the reliability of radiographic methods for assessing the mineralization grade of bones. Information obtained from some selected bones cannot, however, be generalized, because the mineral content of different bones and parts of bones varies in close relationship with their functional and nutritional conditions (*Strobino & Farr*, 1949; *Trotter & Peterson*, 1955).

Only few data are available on the correlation between the dry density and true mineral content of mandibular bones. Moreover, these data relate to complete mandibles or some random pieces of mandibular bone (*Trotter & Peterson*, 1955; *Calonius et al.*, 1965). The aim of the present study was thus to examine the correlation between the dry, fat-free weight and the ash weight i.e. the mineral content of the mandibular body, ramus and condyle.

### MATERIAL AND METHOD

Ten mandibular bones removed *post mortem* from 6 males and 4 females, aged 28—74, constituted the material examined. The bones were defatted in benzol and thereafter stored at room temperature.

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Due to their different functional demands and corresponding differences in their morphological pattern, the mandibular bodies, rami and condyles were studied separately. Before sectioning the jaws the teeth were extracted. The volumes of the sections were determined with the millet seed displacement method by *Trotter, Broman & Peterson* (1955). Instead of millet seed, however, smaller grained manna groats were used. Volume measurements were made with glass cylinders, the size of which was accommodated to the size of the bone sections so as to improve accuracy. The nutrient foramina and the cross cut surfaces of the bone sections were coated with thin tape. By vibrating the groats mechanically equal compression was obtained in each determination. The volumes were measured twice and the average of the measurements was used to represent the true volume. The average absolute difference in volume between the first and second series of measurements expressed in percentages of the average of the first measurement was 3.7 % for the mandibular body, 3.4 % for the mandibular ramus and 2.4 % for the mandibular condyle. These differences were considered the percentual error of the volume determination (*Trotter et al.*, 1960). The weight of the groats displaced by the bones was determined. The volumes of the bones were obtained by dividing the weight of the displaced groats by their specific gravity.

The dry weight density was obtained by dividing the dry weight of the bone by its volume. After this the bones were ashed to constant weight in an electrical oven at a temperature of 900°C and the weight of the ash obtained was determined with a laboratory balance. The calcium content of the ashed bone samples was then estimated with a Perkin-Elmer atomic absorption spectrophotometer using the standard methods suggested in the manual of manufacturer.

#### RESULTS

The mandibular bone proved to be one of the densest bones in the human skeleton. The mean bone density obtained for the mandibular bodies was 1.33 gcm<sup>-3</sup> (S.D. 0.15), for the mandibular rami 1.23 gcm<sup>-3</sup> (S.D. 0.26), and for the mandibular condyles 0.81 gcm<sup>-3</sup> (S.D. 0.16). The high density values of the mandibular body and ramus were due to the predominance of compact bone. The small differences observed in the density of the bones of the right and left sides were neither statistically significant nor systematic. The standard deviation of the bilateral individual variation of the bone density of the mandibular bodies was 0.25 gcm<sup>-3</sup>, that of the mandibular rami 0.16 gcm<sup>-3</sup> and that of the mandibular condyles 0.14 gcm<sup>-3</sup>.

The percentages of the ash weight of the mandibular bodies, rami and condyles from the dry, fat-free weights were 64.4 % (S.D. 0.9), 64.8 % (S.D. 1.0) and 61.8 % (S.D. 2.1). These values were slightly lower than those reported by Trotter & Petersen, (1955). However, in the study of Trotter and Peterson four mandibles out of the seven analyzed contained teeth.

The calcium percentages from the dry, fat-free weights of the corresponding mandibular parts were 24.8 % (S.D. 1.0), 26.2 % (S.D. 1.2) and 23.3 % (S.D. 1.0), and showed a close similarity to results reported earlier (Dollerup, 1964: *Calonius et al.*, 1965).

#### DISCUSSION

A highly significant difference at a level of  $P < 0.001$  could be found between the ash weight of the condyles and the ash weights of the bodies and rami. A significant difference was also noted between the calcium contents of these three mandibular parts. Apparently the different calcium values of the ramus, the body, and the condyle are partly due to a higher calcium content in compact bone than in cancellous bone (*Calonius et al.*, 1965) and partly to variations in the bone composition itself (*Strobino & Farr*, 1949). The data of this study show that considerable differences may exist in the mineral and calcium content between the mandibular bodies, rami and condyles. However, the mineral and calcium content of the mandibular bodies, rami and condyles are separately well correlated with their respective dry weights.

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#### SUMMARY

Dry density (dry, fat-free weight per volume unit), ash weight and calcium content of mandibular bodies, rami and condyles were studied. 10 human mandibles comprised the material. The mean densities obtained for the mandibular bodies were  $1.33 \text{ gcm}^{-3}$  (S.D. 0.15), for the rami  $1.23 \text{ gcm}^{-3}$  (S.D. 0.26), and for the condyles  $0.81 \text{ gcm}^{-3}$  (S.D. 0.16). The small differences observed in the density between the right and left side were not significant. The percentages of the ash weights i.e. mineral contents of the mandibular bodies, rami and condyles were 64.4 % (S.D. 0.9), 64.8 % (S.D. 1.0) and 61.8 % (S.D. 2.1). The calcium content of the bone samples was analyzed with atomic absorption spectrophotometry. The percentual calcium value obtained for the mandibular bodies was 24.8 % (S.D. 1.0), for the rami 26.2 % (S.D. 1.2) and for the condyles 23.3 % (S.D. 1.4).

## RÉSUMÉ

## DENSITÉ ET TENEUR EN SUBSTANCES MINÉRALES DE MANDIBULES HUMAINES

Cette étude a porté sur la densité sèche (poids sec, sans matières grasses, de l'unité de volume), le poids des cendres et la teneur en calcium de corps de la mandibule, de branches montantes et de condyles. Le matériel comprenait dix mandibules humaines. Les densités moyennes déterminées ont été de 1,33 g/cm<sup>3</sup> (Ecart-type 0,15) pour les corps de la mandibule, 1,23 g/cm<sup>3</sup> (E.-T. 0,26) pour les branches montantes et 0,81 g/cm<sup>3</sup> (E.-T. 0,16) pour les condyles. Les petites différences observées entre les densités des côtés droits et gauches n'étaient pas significatives. Les pourcentages du poids des cendres, c'est-à-dire la teneur en substances minérales des corps de la mandibule, des branches montantes et des condyles étaient de 64,4% (E.-T. 0,9), 64,8% (E.-T. 1,0) et 61,8% (E.-T. 2,1). La teneur en calcium des spécimens d'os a été analysée par spectrophotométrie d'absorption atomique. La proportion de calcium trouvée pour les corps de la mandibule était de 24,8% (E.-T. 1,0), pour les branches montantes, elle était de 26,2% (E.-T. 1,2) et pour les condyles 23,3% (E.-T. 1,4).

## ZUSAMMENFASSUNG

## DIE DICHTEN UND DER MINERALGEGHALT DER MENSCHLICHEN MANDIBULA

Untersucht wurden trockene Dichte (trockenes, fettfreies Gewicht pro Volumeneinheit), Aschgewicht und Kalziumgehalt der Mandibula Körper, Rami und Kondylen. Das Material bestand aus 10 menschlichen Mandibeln. Eine mittlere Dichte von 1.33 gcm<sup>-3</sup> (S.D. 0.15) für die Mandibula Körper, von 1.23 gcm<sup>-3</sup> (S.D. 0.26) für die Rami, von 0.81 gcm<sup>-3</sup> (S.D. 0.16) für die Kondylen wurde erhalten. Der kleine Unterschied, der zwischen der linken und der rechten Seite bestand, war nicht von Bedeutung. Die prozentualen Anteile der Aschgewichte d.h. die mineralen Anteile der Mandibula Körper, Rami und Kondylen waren 64.4% (S.D. 0.9), 64.8% (S.D. 1.0) und 61.8% (S.D. 2.1). Der Kalziumgehalt der Knochenstücke wurde mit Atomabsorptionsspectrophotometrie analysiert. Der prozentuale Kalziumwert, den man für den Mandibula Körper erhielt, war 24.8% (S.D. 1.0), für die Rami 26.2% (S.D. 1.2) und für die Kondylen 23.3% (S.D. 1.4).

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