

# Radiographic Determination of the Length of Maxillary and Mandibular Incisors in Rats

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*The length of rat incisors was measured radio graphically, and was constant in rats of the same weight, sex, and strain. The right and left maxillary and mandibular incisors were of equal length in the same rat. The mandibular incisor was consistently about 25% longer than the maxillary incisor for all parameters measured.*

Despite the wide use of radiographs as a tool in dental research, they have been used infrequently in solving specific problems related to the molars or incisors of the rat.<sup>1-3</sup>

This radiographic study was undertaken to answer two questions. First, could a reproducible dental radiograph be made of a rat jaw from which an accurate measurement of the incisor length could be obtained? Second, is the length of the incisor from different rats of the same strain and of the same body weight equal, or is incisor length a parameter that is subject to individual variability? The data in the literature on incisor length were unreliable because the number of animals used and the criteria for measuring tooth length were not indicated clearly.<sup>4</sup>

## Materials and Methods

Twelve male Sherman rats that weighed about 100 gm each ( $95 \pm 7$  gm) were used. Before they were killed each rat was weighed and placed in a jar with ether until respiration ceased. The head of each rat was removed and the jaws were dissected, cleaned of soft tissue, and split into quadrants that were placed in 70% ethanol. A standard dental radiographic unit<sup>a</sup> and "occlusal

film"<sup>b</sup> were used. Occlusal film was selected since it contains two films, both of which were exposed. This allowed one film to be used as a record and one to be used in the measurement procedure, which tended to damage the emulsion.

The head of the radiographic unit was positioned four feet from the level of the film, and the film was positioned perpendicular to the cone of the radiographic head. A jaw quadrant was placed on the film so that the incisor lay parallel and as close to it as possible. The upper jaw quadrants were positioned with the mesial surface toward the films; the lower quadrants were placed so that the lateral surface lay next to the film. These were the flattest surfaces and thus provided the closest apposition of tooth to film. An exposure time of 2.5 seconds at 80 kv was used. Five separate films were exposed for each jaw quadrant. The films were developed in an automatic film processor. Measurements of the radiographs were made with a sliding ocular<sup>c</sup> mounted on a dissecting microscope of fixed magnification. The ocular was standardized with a stage micrometer.<sup>d</sup>

## Results

Figure 1 is an example of the type of radiograph obtained. The features of jaw morphology were visible clearly, as were the limits of the curved maxillary and mandibular incisors.

DEFINITION OF MEASUREMENT PARAMETERS.—In the radiographs, the lengths were measured along the radiopaque line, which represents the calcified enamel and dentin on the labial curvature of the tooth (Fig 2).

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<sup>a</sup> Ritter Corp., Rochester, NY.

<sup>b</sup> Kodak, Eastman Kodak Co., Rochester, NY.

<sup>c</sup> Ernst Leitz Wetzlar, W Ger.

<sup>d</sup> Bausch and Lomb, Rochester, NY.

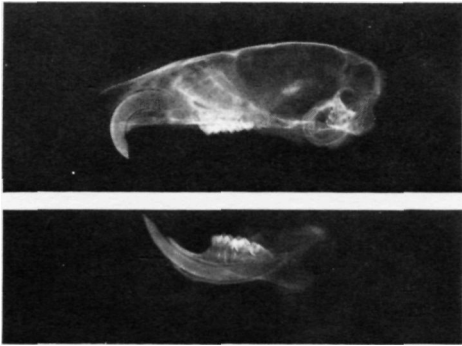


FIG 1.—Upper and lower jaw quadrants of a 100 gm rat (orig mag X1). Measurements were made from similar radiographs, but because of small size, lengths were measured at a higher magnification under a dissecting microscope.

In each tooth, three different length measurements were taken. These were made along the labial surface between four radiologically recognizable points. These points were (1) the posterior limit of the alveolar socket, (2) the point close to the apical end at which calcified enamel and dentin became visible as a radioopaque line, (3) the anterior limit of the alveolar bone on the

lingual surface, and (4) the incisal edge of the tooth (Fig 2). Points 2 and 4 were located on the labial surface of the tooth and therefore, were on the line of measurement. A line through points 1 and 3 drawn perpendicularly to the labial line of measurement defined the measuring points for 1 and 3 (as indicated by arrows in Fig 2). The three different measurements were taken as follows: measurement A, between points 2 and 3 on the labial line of measurement, represents the length of embedded portion of calcified enamel and dentin; measurement B, between points 1 and 3, represents the total length of the embedded portion of the incisor; and measurement C, between points 1 and 4, represents the total length of the incisor.<sup>e</sup>

STANDARDIZATION OF THE RADIOGRAPHIC PROCEDURE.—To test the validity and repro-

<sup>e</sup>The total length of the incisor, as defined here, is somewhat longer than the actual incisor length, because the measurement was made from the incisal tip to the posterior limit of the alveolar socket. The actual incisor length is shorter by the distance between the alveolar bone and the posterior limit of the incisor (which is not calcified and hence not seen in radiographs, but which was measured histologically as  $0.165 \pm 0.033$  mm on the maxillary and  $0.263 \pm 0.049$  mm on the mandibular incisor).

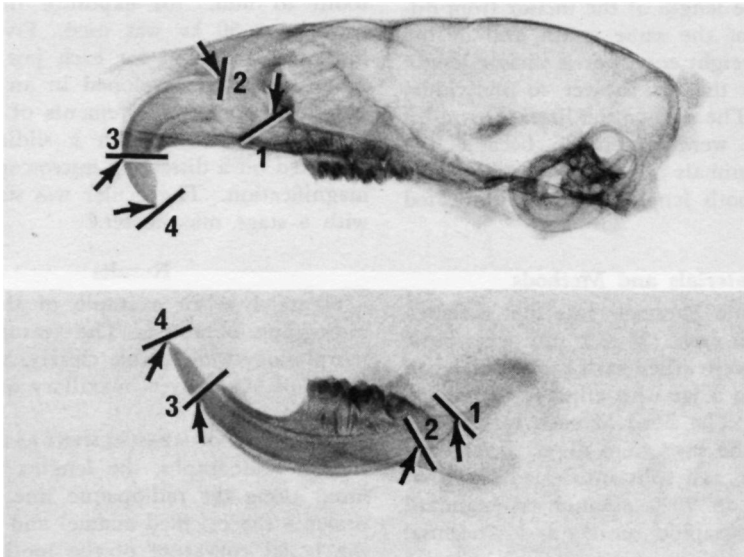


FIG 2.—Positive print of radiographs shows location of points used in measurements (orig mag x2). Point 1, posterior limit of alveolar socket; point 2, point close to apical end at which calcified enamel and dentin (white line) become visible; point 3, in line with anterior limit of lingual alveolar bone; point 4, incisal edge of tooth.

ducibility of the radiographic method, five separate radiographs were made of each jaw quadrant. The measurements were made on each of the five radiographs and the individual values for the maxillary and mandibular right incisor of a rat that weighed 104 gm are shown in Table 1. The small degree of the spread of the values, as indicated by the low standard deviation, demonstrated the reproducibility of the measurements taken from the radiographs between the various points indicated on Figure 2.

MEASUREMENTS OF INCISOR LENGTHS.—The mean values obtained from measurements of the tooth parameters *A*, *B*, and *C*, are presented in Table 2. The value for each parameter is the mean of five measurements from each incisor of 12 rats weighing an average of  $95 \pm 7$  gm. The results demonstrated that there were no differences in the lengths of the right and left incisors of the same animal; thus, the values for both incisors of the same rat could be averaged (Student's *t* test). The combined means of the maxillary and mandibular incisors for the three length parameters (*A*, *B*, and *C*) also are shown in Table 2. There were no significant differences in the lengths of the teeth between different rats in the group. For example, in comparing the values for parameter *C* (total length of the incisor) the maximum standard deviation did not exceed 3.3% of the total length. This indicated that the incisor length in rats of equal weight is almost constant.

There is, however, a pronounced difference in length between the maxillary and

mandibular incisors. The total length of the mandibular incisor (parameter *C*), is 24.4% longer than the maxillary incisor. Also, the total length of the embedded portion of the incisor (parameter *B*) and the total length of the embedded portion of calcified enamel and dentin (parameter *A*) are 27.5 and 25.2% longer, respectively, in the mandibular incisor than in the maxillary incisor. Thus, the mandibular incisor was about 25% longer than the maxillary incisor for all the parameters measured.

### Discussion

The continuously erupting incisor of the rat is a useful biologic system in which to study the events and sequences in tooth development.<sup>5</sup> However, the continuous eruption of the incisor is accompanied by a continuous increase in body weight of the rat and in the overall size of the incisor. To further develop the usefulness of the incisor in quantitative studies of tooth growth and development, it is necessary to establish the reproducibility of parameters such as tooth length, so that valid comparisons can be made between animals. The results presented in this study demonstrate clearly the following points about the length of the incisor in male Sherman rats that weigh about 100 gm: The right and left incisors, maxillary and mandibular, are equal in length within the same rat. The length of the maxillary and mandibular incisors is constant in rats of similar weight. Thus, rat weight can be satisfactorily correlated with incisor length. The mandibular incisor

TABLE 1  
REPRODUCIBILITY OF MEASUREMENTS FROM FIVE RADIOGRAPHS OF SAME TEETH FROM A  
RAT WEIGHING 104 GM

Radiograph	Maxillary Right			Mandibular Right		
	<i>A</i> *	<i>B</i> †	<i>C</i> ‡	<i>A</i>	<i>B</i>	<i>C</i>
1	10.852	13.346	17.645	14.241	17.749	22.785
2	11.396	13.945	17.960	14.212	17.734	22.733
3	11.337	13.782	17.771	14.497	17.693	22.725
4	11.666	13.949	17.997	14.312	17.360	22.629
5	11.514	13.771	18.034	14.878	17.679	23.069
Mean $\pm$ SD	11.353 $\pm$ 0.307	13.759 $\pm$ 0.246	17.881 $\pm$ 0.167	14.428 $\pm$ 0.275	17.643 $\pm$ 0.161	22.788 $\pm$ 0.167

Note: Values are in millimeters. SD, standard deviation.

\* *A*, length of embedded portion of calcified enamel and dentin.

† *B*, total length of the embedded portion of the incisor.

‡ *C*, total length of the incisor.

TABLE 2  
MEAN LENGTHS OF INCISORS AS AVERAGED FROM 12 RATS (95 ± 7 gm mean body weight)

A*	Maxillary Right			Maxillary Left			Mandibular Right			Mandibular Left		
	B†	C‡	A	B	C	A	B	C	A	B	C	
10.820	13.128	17.261	10.805	13.120	17.400	14.695	17.988	22.746	14.664	18.204	23.013	
±0.317	±0.506	±0.567	±0.367	±0.458	±0.396	±0.673	±0.551	±0.673	±0.551	±0.527	±0.771	
Combined Maxillary												
A	B	C										
10.813 ± 0.256	13.124 ± 0.462	17.330 ± 0.465	14.646 ± 0.522			18.091 ± 0.538			22.916 ± 0.698			
0.9 ≤ PS ≤ 1.0	0.9 ≤ PS ≤ 1.0	0.4 ≤ PS ≤ 0.5	0.8 ≤ PS ≤ 0.9			0.3 ≤ PS ≤ 0.4			0.3 ≤ PS ≤ 0.4			

Note: Values are in millimeters. SD, standard deviation.  
 \* A, length of embedded portion of calcified enamel and dentin.  
 † B, total length of the embedded portion of the incisor.  
 ‡ C, total length of the incisor.  
 § Student's t test for any difference between right and left incisors.

is approximately 25% longer than the maxillary incisor.

The results also demonstrate the potential value of the radiographic method as a means for standardizing quantitative measurements related to the calcified tissues of rat incisors. We have established that the length of the rat incisor is consistent in rats of similar weight; now it is possible to define the various stages of ameloblast structure and function in quantitative terms.<sup>6</sup> This in turn will permit more accurate studies of the dynamics of cell turnover, migration, and population kinetics in these teeth.

**Conclusions**

The right and left maxillary and mandibular incisors of male Sherman rats (about 100 gm in body weight) were equal in length within the same rat. The length of the maxillary and mandibular incisor was constant between rats of similar weight, sex, and strain. Hence, length can be used as a reproducible parameter for studies of turnover and renewal of the incisor.

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