

# AN EXPERIMENTAL STUDY OF CHANGES IN THE WEIGHT OF THE MANDIBLE AFTER LOSS OF LOWER POSTERIOR TEETH

BY

Hiroshi AMEMORI, Yutaka SATO and Masato KAWAKAMI\*

## ABSTRACT

The purpose of this study was to observe the influence of loss of the lower teeth on the weight of the mandible. The materials used in this experiment consisted of sixty-seven mongrel dogs, which were extracted on lower right posterior teeth with the exception of control animals, and which were classified according to their age, sex, number of extracted teeth and time after extraction of teeth. Two halves of their mandibles were weighed separated from each other, and the right half, namely the operated side was set against the left, the control side to estimate the changes of the mandible in weight following extraction of the lower teeth.

The following results were obtained: The weight of the mandible extracted on lower posterior teeth decreases in growing animals, and appears to be diminished in the mature, although it increases transiently. There is a distinct difference in the change of the weight between the growing dog and the mature, and that is, the former has an intenser change than the later. But there is no significant difference between the male and the female, and also between the animals extracted on all lower posterior teeth and those extracted on the lower first molar. The weight of the mandible in the growing decreases significantly in six months after the loss of the teeth, but subsequently ceases to change. In the mature animal it remains unchanged in three months after the extraction of the teeth, then increases significantly in the period between third month and twelfth, and decreases distinctly afterwards.

## INTRODUCTION

One of the authors of this article has carried out the animal experiments to elucidate the changes in the form of the mandible following loss of the lower teeth. According to his observations<sup>1)</sup>, the mandible shows alterations in form as a whole, especially in the growing animal. The length of the mandible, the width of the *caput mandibulae* and the *ramus mandibulae*, the height of the coronoid process of the mandible, and also the heights of the mandibular body in the part of the extracted teeth decreases

\* 雨森 洋, 佐藤 裕, 河上正人: 1st Department of Prosthetic Dentistry (Chief: Prof. I. NAKAZAWA), School of Dentistry, Tokyo Medical and Dental University (Tokyo Ika Shika Daigaku).

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significantly after the extraction of the teeth. The mandibular body is diminished in square measure of the frontal section at the edentulous portion<sup>2)</sup>, and appears to show alteration in the shape of the *basis mandibularis* as well as of the *pars alveolaris*<sup>3)</sup>.

It is likely to suppose that these dimensional changes may be followed by the alteration in the weight of the mandible. It is, therefore, the purpose of this study to demonstrate the effect of the loss of the teeth on the weight of the mandible.

#### MATERIALS AND METHOD

Sixty-seven mongrel dogs were used in this experiment, and grouped on the basis of their age, sex, number of extracted teeth and lapse of time after extraction of the teeth as shown on Table 1. They were extracted on the lower right posterior teeth under general anesthetization with pentobarbital sodium, kept for three, six, twelve or twenty-four months, and sacrificed at the end of the period of maintenance. Their mandible was removed, and bathed in water for nearly one month in summer or five months in winter for the soft tissues to decompose, following by immersing in 0.1 percent sodium hydroxide aqueous solution for 7 days, and in 1 percent hydrogen peroxide aqueous solution for 5 days at 40°C.

Table 1. Classification of Experimental Animals according to Their Age, Sex, Number of Extracted Teeth and Period of Maintenance after Tooth Extraction

Period of maintenance after tooth extraction	with missing teeth			without missing teeth
	The mature animal		The growing animal	
	extracted on $\overline{M_1}$	extracted on $\overline{M_3M_2M_1P_4P_3P_2P_1}$	* extracted on $\overline{m_3m_2m_1}$ and $\overline{M_3M_2M_1P_4P_3P_2P_1}$	
3 months	—	5. (Group 2)	—	23. (Group 1)
6 months	—	6. (Group 3)	3. (Group 7)	
12 months	—	7. (Group 4)	5. (Group 8)	
24 months	6. (Group 6)	14. (Group 5)	—	
		{Subgroup 1 ( $\frac{\text{♂}}{\text{♀}}$ )...6 Subgroup 2 ( $\frac{\text{♂}}{\text{♀}}$ )...8}		

\*  $\overline{m_3m_2m_1}$  were extracted at two or four months of age and successively  $\overline{M_3M_2M_1P_4P_3P_2P_1}$  extracted from five to seven months of age.

The mandible of a dog from which the soft tissues had been excoriated

was divided into the right half and the left at the *symphysis mandibulae*. The two halves of the desiccated mandible from which the remaining teeth were removed weighed separately with a balance (semi-micro B5 C100 type, Mettler, the readability of which is 0.01 mg.) The mean values and the standard deviations of the weights in Group 1 were contained in Table 2. It is remarkable that the bilateral difference is very small in mean values.

Table 2. Mean Values and Standard Deviations of the Weights of Bilateral Halves of the Mandible for Group 1

	Mean values (g.)	Standard deviations (g.)
Right side	19.13	6.06
Left side	19.21	6.13

Table 3. Data for Estimating the Difference of Bilateral Mandibular Halves in Weight According to the Formula  $\{(R-L)/(R+L)\} \times 100(\%)$

Mean value (%)	Standard deviation (%)	Confidence interval (95% level)
-0.185	0.575	$-0.416 \leq \mu \leq +0.046$

The weight of the right half (R), or the operated side, was compared with that of the left half (L), or the control side, to eliminate individual variation in the weight of the mandibular bone:

$$\frac{R - (R + L)/2}{(R + L)/2} \times 100 = \frac{R - L}{R + L} \times 100(\%)$$

The mean value and the standard deviation of the value  $\{(R-L)/(R+L)\} \times 100(\%)$  of Group 1 as well as the confidence interval<sup>4)</sup> of its mean value were tabulated in Table 3. It can be seen that the mean value is very small, and that its confidence interval is narrow and includes zero. These results suggests that the weights of both halves of the mandible may not be significantly different.

#### RESULTS AND DISCUSSION

In each of Group 2, 3, 4, 5, 6, 7, and 8 were calculated the mean values and the standard deviations of the value  $\{(R-L)/(R+L)\} \times 100(\%)$ , for each operated group was different in its experimental conditions from every other group as already described. Those mean values were compared with that of Group 1, the control, in order to manifest the alteration in the weight of the mandibular bone following the extraction of the teeth. Statistical estimate of these comparisons, using the t-test<sup>4)</sup>, showed that there were significant changes in the weight of Group 4, 5, 7 and 8. One, two and three asterisks respectively meant statistical significance at 10, 5 and 1 percent level. The mean values of Group 5, 7 and 8 were negative so that the weight of the mandibular bone decreased in these groups, while the positive

mean value of Group 4 indicated an increase in the weight (Table 4).

Table 4. Mean Values and Standard Deviations of  $\{(R-L)/(R+L)\} \times 100(\%)$  for Group 2, 3, 4, 5, 6, 7 and 8, as Well as Comparisons of the Mean Values between the Operated Group and the Control

	Mean values (%)	Standard deviations (%)	Compared with Group 1 t. (d.f.)
Group 2	-0.589	0.355	1.425 (26)
Group 3	+0.155	0.736	1.151 (27)
Group 4	+0.614	1.033	2.494** (28)
Group 5	-1.329	2.760	1.865* (35)
Group 6	-0.565	1.822	0.831 (27)
Group 7	-7.388	0.586	19.174*** (24)
Group 8	-7.482	2.004	14.236*** (26)

In author's preceding investigations where the same materials were used, the mandible changed markedly in form on account of the loss of the lower tooth. It may be supposed that there was a reciprocal relationship between alteration in the form and the same in the weight of the mandibular bone. The length of the mandible, the height of the *ramus mandibulae*, and the square measures of the frontal sections on the mandibular body were selected to represent roughly the mandible in shape. The length from the *infradentale* (if.) to the *condylion laterale* (cl.) decreased significantly in Group 7 and Group 8 on account of the loss of the teeth, and the linear distance between the *condylion laterale* and the *gonion ventrale* (gov.) increased in Group 3, Group 5, Group 7 and Group 8. The square measures of the frontal sections at the lower fourth premolar, the lower first and the lower second molar diminished evidently in almost all cases after extraction of the teeth<sup>2)</sup>. Table 5 gave the data about the correlation between if.-cl. and the weight. Their correlation coefficient was positive in Group 8 and negative in Group 7. The coefficient of Group 8 was statistically regarded as significant value, but the same of Group 7 was not significant. The correlation coefficients between cl.-gov. and the weight were recorded in Table 6. There were three positive correlation coefficients and one negative, but they were not significant. In Table 7 the correlation coefficients between the square measure of the mandible and the weight were tabulated. It can be seen that they consisted of nine positive values, out of which two were recognized as significant correlation coefficient, and one negative value. These results may incline to the view that the changes of the mandible in

Table 5. Data for Estimating the Correlation of the Changes of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values Following the Loss of the Teeth between the Weight and the Length of the Mandible

Groups	Weight & if.-cl.	
	r.	t. (d.f.)
Group 7	-0.952	3.105 (1)
Group 8	+0.883	3.261** (3)

Table 6. Data for Estimating the Correlation of the Changes of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values Following the Loss of the Teeth between the Weight and the Height of the *Ramus Mandibulae*

Groups	Weight & cl.-gov.	
	r.	t. (d.f.)
Group 5	-0.106	0.562 (12)
Group 7	+0.551	0.661 (1)
Group 8	+0.203	0.359 (3)

Table 7. Data for Estimating the Correlation of the Changes of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values Following the Loss of the Teeth, between the Weight of the Mandible and the Square Measure of the Mandibular Frontal Sections

Groups	Weight & $\bar{P}_4$ -section		Weight & $\bar{M}_1$ -section		Weight & $\bar{M}_2$ -section	
	r.	t. (d.f.)	r.	t. (d.f.)	r.	t. (d.f.)
Group 4	—	—	+0.219	0.502 (5)	+0.193	0.440 (5)
Group 5	—	—	+0.745	3.869*** (12)	+0.702	3.416*** (12)
Group 7	+0.508	0.590 (1)	+0.706	0.996 (1)	+0.983	5.331 (1)
Group 8	+0.453	0.880 (3)	+0.310	0.565 (3)	-0.126	0.220 (3)

form and in weight were positively correlated in a few groups, but generally their correlations were rather negligible.

In Fig. 1 the mean values of  $\{(R-L)/(R+L)\} \times 100(\%)$  of Group 1, Group 7 and Group 8 were plotted against time after loss of the teeth to show the changes of the weight of the mandible in growing animals within twelve months following such loss. The mean value of Group 7 was compared statistically with that of Group 1, and Group 8 compared with Group 7 in order to evaluate the changes of the mandible in weight with time (Table 8). The results to be drawn from these comparisons showed that the weight of the mandible decreased significantly in six months after extraction of the teeth, but afterwards appeared to be constant. In Fig. 2 were illustrated by a line graph the mean values of Group 1, 2, 3, 4 and 5. According to comparing the value of Group 1 with that of Group 2, Group 2 with Group 3, Group 3 with Group 4, and Group 4 with Group 5, were found no significant differences in all pairs but one of Group 2 and Group 3 (Table 9). The results obtained here, together with those shown in Table 4,

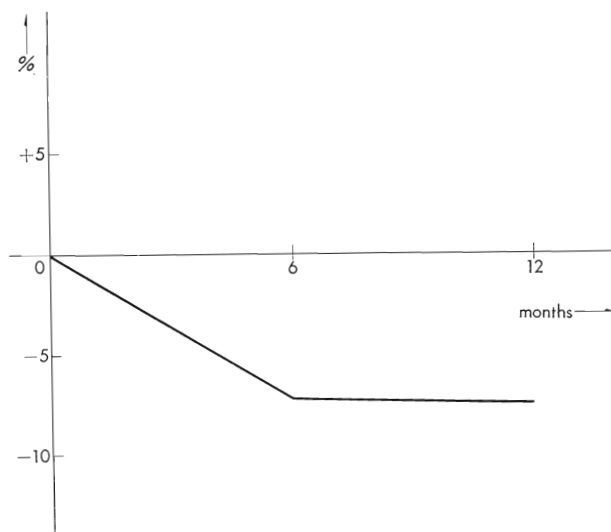


Fig. 1.

Table 8. Data for Estimating the Moving of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values of the Growing Animal within Twelve Months after Extraction of Teeth

Groups	Mean Values (%)	Comparisons t. (d.f.)
Group 1 & Group 7 (6 months)	-0.185 } -7.388 }	19.174*** (24)
Group 7 & Group 8 (12 months)	-7.388 } -7.482 }	0.069 (6)

suggested that in mature animals the weight of the mandible remained unchanged during three months following the extraction of the teeth, then increasing in the period from third month to twelfth month, and that it decreased afterwards.

It was of great interest that the mandible decreased in the dimensional measurements from third month to twelfth, as proved in author's previous studies, but that it increased in weight. The observation on forty-six operated mandibles showed that extraction wounds had been healed. Perhaps it may suggest that the increment of the weight was referred to the healing of extraction wounds, where the sockets were filled by newly formed bone<sup>5,6</sup>. In the roentgenograms of the mature dogs extracted on  $\overline{M_3M_2M_1P_4P_3P_2P_1}$ , the sockets remained visible as bounded by the *linea alba* in all mandibular bones of Group 2 and 3, namely until sixth month after the extraction of

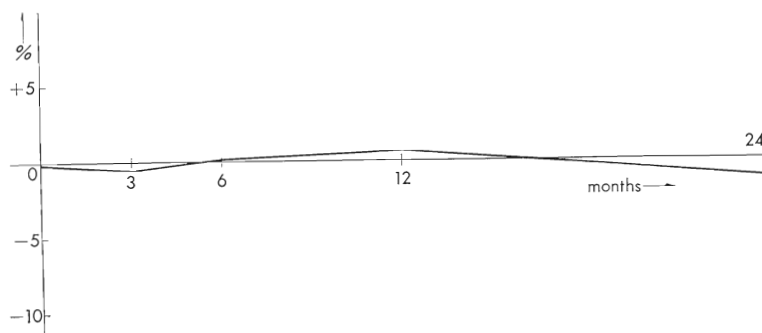


Fig. 2.

Table 9. Data for Estimating the Moving of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values of the Mature Animals within Twenty-four Months after Extraction of Teeth

Groups	Mean Values (%)	Comparisons t. (d.f.)
Group 1 & Group 2 (3 months)	-0.185 } -0.589 }	1.425
Group 2 & Group 3 (6 months)	-0.589 } +0.155 }	1.876*
Group 3 & Group 4 (12 months)	+0.155 } +0.614 }	0.836
Group 4 & Group 5 (24 months)	+0.614 } -1.329 }	1.539

the teeth. At twelfth month they appeared in two specimens out of seven, and at twenty-fourth month it remained visible only in two out of fourteen, so that the reconstructive process of the bone scar had almost finished until twenty-fourth month (Fig. 3). It may be, therefore, thought that the decrease of the weight in the period from twelfth month to twenty-fourth was attributed to the reconstruction of the mandibular bone as well as to the dimensional decrease.

In Table 10 were compared the mean value of  $\{(R-L)/(R+L)\} \times 100 (\%)$  of Group 3 with that of Group 7, and the value of Group 4 compared with that of Group 8 in order to determine the difference of the change in weight between the growing and the mature. The results to be drawn from these comparisons clearly revealed that the weight of the mandible in the growing changed to a greater extent than that in the mature.

With the purpose of estimating the difference of  $\{(R-L)/(R+L)\} \times 100 (\%)$  between the male and the female, the comparison between two sub-groups of Group 5 was made. It was evident from Table 11 that no signifi-



Fig. 3(A). A specimen of Group 1, the control



Fig. 3(B). A specimen of Group 3





Fig. 3(C). A specimen of Group 4, in which the sockets are invisible

Table 10. Comparisons of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values between the Mature and the Growing

	Group 3 & Group 7	Group 4 & Group 8
t. (d.f.)	13.638***(7)	8.331***(10)

Table 12. Comparison of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values between Group 5 Extracted on the All Lower Posterior Teeth and Group 6 Extracted on the Lower First Molar

	Group 5 & Group 6
t. (d.f.)	0.591 (18)

Table 11. Mean Values and Standard Deviations of  $\{(R-L)/(R+L)\} \times 100(\%)$  Values for Subgroup 1 and 2, and also Comparison of the Mean Values between These Subgroups

Subgroups	Mean values (%)	Standard deviations (%)	Comparison t. (d.f.)
Subgroup 1 (♂)	-1.093	2.780	} 0.257 (12)
Subgroup 2 (♀)	-1.505	2.731	

cant difference was found between them.

Group 6 which had been extracted on the lower first molar was compared with Group 5 extracted on all lower posterior teeth (Table 12). It showed that Group 6 was not significantly different from Group 5 in the change of the weight.

## CONCLUSIONS

(1) The weight of the mandible extracted on all lower posterior teeth decreases in the growing animal, and appears to be diminished in the mature, although it increases transiently at twelfth month following extraction of the teeth.

(2) In the growing animal, the weight of the mandible decreases significantly in six months following the loss of the teeth, but afterwards ceases to change. But in the mature it remains unchanged during three months after extraction of the teeth, then increases in the period between third month and twelfth, and afterwards decreases until twenty-fourth month.

(3) There is a distinct difference in the change of the weight between the growing dog and the mature, and that is, the former exceeds significantly the later. But there is no significant difference between the male and the female, and also between animals extracted on all lower posterior teeth and those extracted on the lower first molar.

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