# Tissue Changes Occurring in Dogs Incident to Depressing Movements*

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It is surprising that an orthodontic movement as frequently employed in treatment as that of depressing teeth should have received so little study from an objective standpoint. Generally, studies of tissue changes† have concerned themselves mainly with the labial, lingual and buccal tipping of teeth. In several instances clinical depression is referred to, but little histological evidence is presented to substantiate theorizing.

Oppenheim must be credited[2,5,19] with carrying out a systematic and organized research upon histological changes occurring with the application of orthodontic force. Initially he experimented[9] upon fully formed deciduous teeth of monkeys. Due to the fact that the permanent tooth germ was in close proximity to the deciduous tooth studied, Oppenheim was unable to observe periapical bone change. The periapical reactions in his studies of depressing tooth movements were not specifically discussed for this reason. However, he observed in the apical end of the lateral axial wall of some tooth sockets typical pressure reactions similar to those noticed in labial and lingual tipping.

Stuteville in his dog experiments, records[18] causing depression while tipping a third premolar.

Kronfeld asserted[4] that during depression, resorption of the entire surface of the socket occurs. He found this resorption most extensive at the alveolar base and crest.

## Outline of Experimentation

The intention of this study was to ascertain tissue changes occurring in dogs following depression of teeth. In this experiment, because of their anatomical configuration as well as their size, maxillary and mandibular second incisors of a one year old dog were used. (An animal one year old was used because it has been shown[15] that root end formation in the dog is complete at about one year of age and that thereafter much elasticity of the alveolar process is rapidly lost.) Teeth adjacent to these were used as controls. It was endeavored to approximate, as nearly as possible, depression conducted clinically in the human mouth. The force applied, distance through which this force acted and the time interval between adjustments were made as nearly constant as possible (see Table I).

The appliance illustrated in Figure 1 was used to depress these incisors.

* The material from which this paper was prepared was gathered in the Orthodontic Section, Northwestern University Dental School in partial fulfillment of the requirements for the degree of Master of Science in Dentistry.

† By Sandstedt,[15] Oppenheim,[8,9,10] Gottlieb and Orban,[1,11,12,13] Schwarz,[16,17] Johnson, Appleton and Rittershofer,[3] Marshall,[6,7] Rehak,[14] Stuteville,[16,19] and others.

TABLE I. SUMMARY

| Group | Tooth | Total Time | Adjustment Interval | Average Force* | Distance Activated | Times Reactiv.† | Time Retained | Distance Depressed |
|---|---|---|---|---|---|---|---|---|
| 1 | $\underline{\lvert 2}$ | 35 Days | 7 Days | 48 g. | 1 mm. | 5 | 0 | 1.9 mm. |
| 2 | $\underline{2\rvert}$ | 35 Days | 7 Days | 51 g. | 1 mm. | 5 | 0 | 1.0 mm. |
| 3 | $\overline{\lvert 1}$ | 28 Days | 7 Days | 53 g. | 1 mm. | 4 | 0 | 1.1 mm. |
| 4 | $\overline{2\rvert}$ | 28 Days | 7 Days | 69 g. | 1 mm. | 4 | 6 Hrs. | 0.8 mm. |

* Mean average was obtained by totaling the forces effective during each separate 7 day interval and dividing this total by the number of adjustments.

† The last adjustment was made six hours before the experiment was terminated.

Adjustments upon it are summarized in Table I. Since these auxiliary springs demonstrated depressing force remaining at each reactivation, it can be said that a clinically continuous force was used for the experiment.

An onlay, cemented upon the lower left second molar when the appliance was activated, opened the anterior vertical denture space approximately 5 to 6 mm., apparently bilaterally symmetrical. Thus, it may be reasonably assumed that all tooth movements were induced by the appliance rather than by function.

After each adjustment, compound impressions were so taken that labial overhang would clearly show the relation of incisal edges on each tooth to the compound. Progressive stages of depression and changes at the conclusion of experimentation were observed and measured by com-

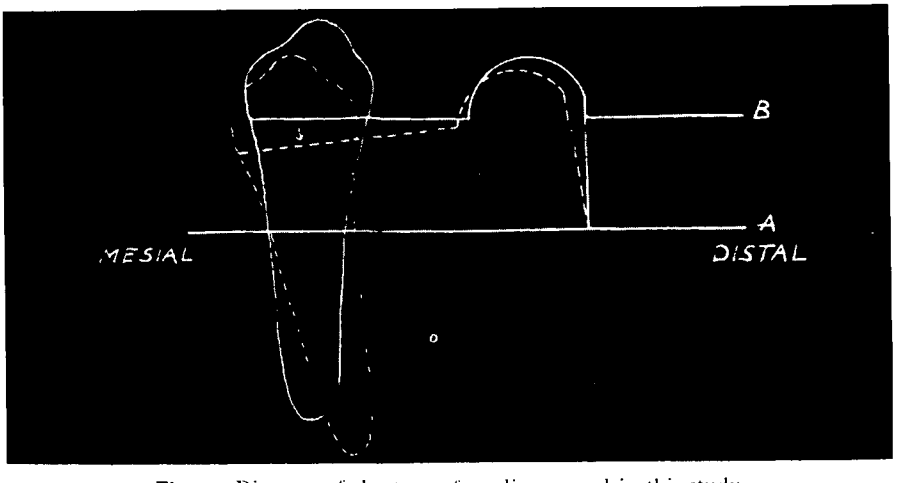


**Fig. 1.**—Diagram of the type of appliance used in this study.

paring relative positions of the incisal edges to the compound overhanging.

Upon the conclusion of experimental procedures, excised portions with adjacent control teeth, were prepared and sectioned in labio-lingual and mesio-distal longitudinal sections and also in horizontal section.

## Experimental and Clinical Results

At the termination of experiments it was observed that all teeth upon which forces had been applied were depressed from 0.8 mm. ([2]) to 1.9 mm.

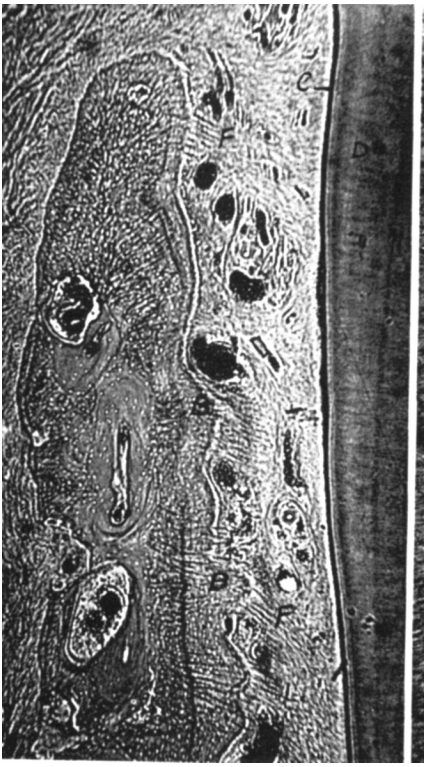


Fig. 2

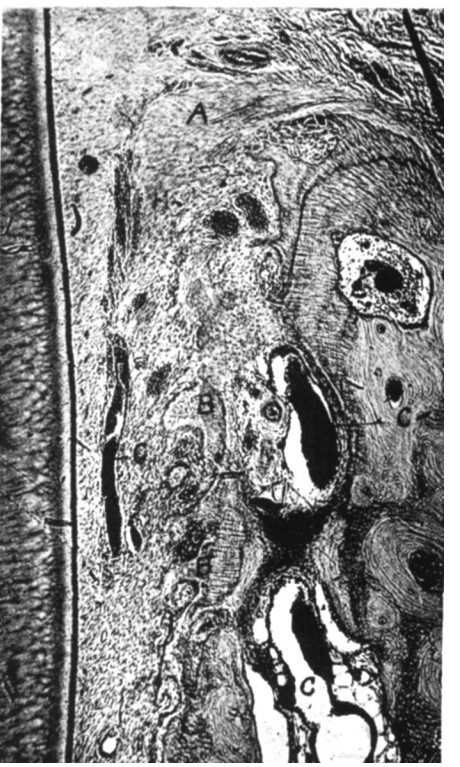


Fig. 3

**Fig. 2.**—Labial surface showing apically inclined new bone trabeculae, B, and apically inclined peridental membrane fibres, F, Cementum, C, Dentin, D.

**Fig. 3.**—Lingual surface showing apically inclined fibres of the peridental membrane; Alveolar crest group, A; Horizontal group, H; New bone trabeculae, B; Circulatory congestion, C.

([2]). Judging by clinical observations and comparative impressions, movements of these teeth incidental to depression included minor movements in other directions. Slight mesio-distal tipping appeared regularly as a constant movement during depression. Labio-lingual tipping, sometimes occurring incidentally, was not always exhibited.

It is noteworthy to observe that on the depressed teeth no depression, measurable in extent, was shown during the first seven days of adjustment. In fact the lower right second incisor showed no depression until 14 days

of activation. Depression in all four teeth studied, when it did start, was at first over only a short distance. However, more and more movement comparatively was observed as the experiment progressed.

## Histological Considerations

Histological examination generally demonstrated irregular resorption and deposition of bone in the alveolar process adjacent to the depressed teeth. In most instances where bone resorption could be shown histologically on the alveolar process at the apex of a depressed tooth the contiguous supporting bone of the marrow spaces opposite this resorption area did not demonstrate observable change. In no instance could resorption be shown in the alveolus around an entire tooth.

No constancy of architectural arrangement in bone newly deposited during depression could be observed. Frequently, bone spicules were oriented[9,15] in the direction of peridental membrane tension, but there likewise appeared many irregular linear depositions. On these surfaces, however, the peridental membrane fibres showed a definite alteration in direction. The oblique group ran at a greatly exaggerated apical, acute angle in passing from the bone to the tooth; the horizontal group assumed a slight apical direction, while the alveolar crest group ran in a looped direction from tooth to bone.

These changes in the peridental membrane, together with the above mentioned arrangement of new bone spicules, would seem to be the pattern that should be consistent in depression if other movements did not interfere.

Several instances of cementum resorption appeared. Usually they were adjacent to areas where the peridental space was narrowed. Again whether this cementum resorption was the result of past physiological moulding of bone or the result of depressing the tooth is problematical. From specimens observed in horizontal section the severity of injury leads one to believe that compression, during actual depression, initiated this injury. However, in other cases the etiology of such resorption is more uncertain.

Ultimately, these resorptions appear to have resulted from the existence of conditions between one cementum surface and the surrounding alveolar process or another contiguous cementum surface which favored resorption. Whether these conditions resulted from a tipping movement or the depressing movement is difficult to ascertain, both movements having been present. Since resorption is present here and is not evidenced generally upon the control teeth, if we tentatively assume that incidental tipping movements may accompany depression, it can be concluded that the depression of this tooth, either directly or indirectly, could have caused the resorption noted.

Following depression, conflicting and varying vascular reactions in and adjacent to the peridental membrane were in evidence, apparently depending upon the level at which the section was cut, as well as upon the incidental movements obtained.

Just why an initial period occurs during which no depression could be observed cannot be definitely stated. Possibly complete readjustment of bone architecture upon the pressure side must precede tooth movement.[9] Or a

process similar to undermining resorption might have to be effected before a depressing movement could occur.[13] But, also, it may be suggested logically that compression of the peridental membrane could have initiated injury to blood vessels of the peridental membrane and that the reparative mechanism of these tissues required a period of readjustment (to remove ensuing hemorrhage) before resorption or other bone changes could occur. Until material upon similar constant depressing forces applied for shorter intervals has been examined and evaluated no conclusion can be made. Even then the answer may not be obtainable.

Mechanically, many factors may influence the resulting tooth movement in depression.[15] The width and health of the contiguous peridental membrane, the axial curvature of the tooth root as well as the divergence of

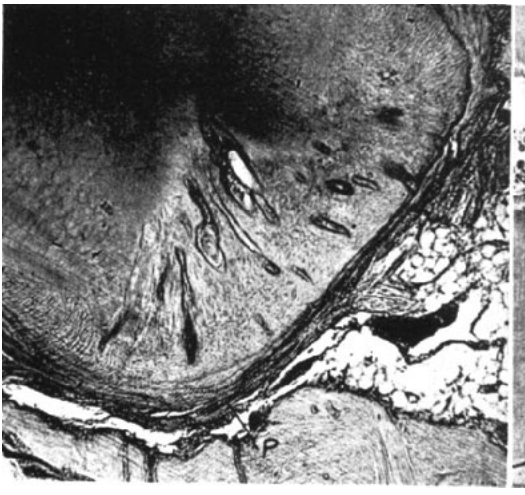


FIG. 4


FIG. 5

**Fig. 4.**—Compression of periapical peridental membrane, P.

**Fig. 5.**—Resorption and repair of tooth surfaces, R, because of tipping of adjacent teeth.

its roots all should be considered in stating what resultant movements would occur. Root shape and size as well as the density, distribution and contour of contiguous alveolar bone are important considerations. Due to the presence of these variables, theoretically, during depression unequal pressures may be produced upon different parts of each tooth socket. This suggests immediately that a combination of straight vertical depression coupled with minor lateral displacements will probably occur upon the application of depressing forces.

As has been shown, it could be maintained that this picture resulted from the application of depressing forces coupled with forces other than those which cause depression. However, since the adjustment was approximately analogous to forces employed orthodontically upon the human dentition for a simple type of depression, it seems reasonable to postulate that movements resultant here simulate to some degree what occurs in the human mouth during depression.

SUMMARY

Histological observation suggests that in uncomplicated areas, new bone spicules took an apical direction, with peridental membrane fibre direction being exaggerated or definitely changed in direction, which should be consistent with a depression movement. Also during the depression of teeth some condition or conditions were created contributing to varying degrees of irregular resorption and deposition of bone upon adjacent alveolar walls. Some contiguous cementum surfaces also demonstrated similar resorptions.

Microscopically resorption around the alveolar process adjacent to the entire tooth could not be demonstrated. However, heavy resorption periapically where no actual compression existed, and frequently at the alveolar crest, were observed.

No periapical reaction, constant to all specimens examined, could be observed. Weight is here given to the opinion that introduction of forces and directions of movement other than straight axial movement apically are an almost invariable result of applying depressiong forces and thus might "normally" be expected during depression, unless compensating adjustments can be made to offset them.

This examination tended to substantiate a clinical orthodontic finding, that during depression of teeth some condition, or conditions, were created so that an interval of time after the application of a depressing force is required before clinical depression occurs. Just why this initial stage, during which the tooth remains unmoved, occurs could not be accurately determined by study of the specimen at hand.

A definite necessity for histological work upon depressing movements as employed in orthodontia is evident.

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## *Bibliography*

1. GOTTLIEB, B. and ORBAN, BALINT. *Biology and Pathology of the Tooth and Supporting Mechanism.* N.Y., Macmillan, 1938.
2. HEIMLICH, A. F. "Tissue Changes Incident to Tooth Movement," *Int. Jnl. Ortho.,* 21:1023-1026, 1935.
3. JOHNSON, A. L., APPLETON, J. L., JR. and RITTERSHOFER, L. S. "Tissue Changes Involved in Tooth Movement." First Int. Ortho. Congress Trans. 1926, pp. 260-269.
4. KRONFELD, RUDOLF. *Histopathology of the Teeth and Their Surrounding Structures.* Phila., Lea and Febiger, 1939.
5. KRONFELD, RUDOLF. *Tissue Changes in Orthodontic Movement,* Chap. 9: Dewey, Martin and Anderson, George, Practical Orthodontia. St. Louis, Mosby, 1935.
6. MARSHALL, J. A. "Study of Bone and Tooth Changes Incident to Experimental Tooth Movement and Its Application to Orthodontic Practice," *Int. Jnl. Ortho.,* 19:1-17, 1933.
7. MARSHALL, J. A. "Root Resorption of Permanent Teeth. II. A Study of Bone and Tooth Changes Incident to Experimental Tooth Movement," *J.A.D.A.,* 17:1221-1235, 1930.
8. OPPENHEIM, ALBIN. "Biologic Orthodontic Therapy and Reality," ANGLE ORTHO., 5:159-211; 233-270, 1933; 6:5-38; 69-116, 1936.
9. OPPENHEIM, ALBIN. "Tissue Changes, Particularly of Bone, Incident to Tooth Movement," *Am. Ortho.,* 3:57-67; 113-132, 1911-1912.
10. OPPENHEIM, ALBIN. "Crisis in Orthodontia. Part I. Tissue Changes During Retention. Skogborg's Septotomy," *Int. Jnl. Ortho.,* 20:542-554, 1934.
11. ORBAN, BALINT. *Dental Histology and Embryology.* Phila., Blakiston, 1928.

12. ORBAN, BALINT. "Biologic Problems in Orthodontia," *J.A.D.A.*, 23:1849-1870, 1936.
13. ORBAN, BALINT. "Tissue Changes in Traumatic Occlusion," *J.A.D.A.*, 15:2090-2106, 1928.
14. REHAK, R. "Tissue Changes During Orthodontic Treatment," *Dent. Record*, 56:193-202, 1936.
15. SANDSTEDT, C. "Einige Beitrage zur Theorie der Zahnregularierung," *Mord. Tand. Tidsskr.*, Heft 4, 1904, 1905.
16. SCHWARZ, A. M. "Tissue Changes Incidental to Orthodontic Tooth Movement," *Int. Jnl. Ortho.*, 18:331-352, 1932.
17. SCHWARZ, A. M. "The Movement of Teeth Subjected to Pressure," *Zeitschrift für Stomatologie.*, 24:49-83, 1928. Translation in N.U.D.S. Library.
18. STUTEVILLE, O. H. "Injuries to the Teeth and Supporting Structures Caused by Various Orthodontic Appliances, and Methods of Preventing these Injuries," *J.A.D.A.*, 24:1494-1507, 1937.
19. STUTEVILLE, O. H. "Injuries Caused by Orthodontic Forces and the Ultimate Results of these Injuries," *Am. Jnl. Ortho.*, 24:103-119, 1938.