meter of saline solution. The ovaries were removed 5 days after the implants were made.

One normal male pituitary increased the average weight of both ovaries from 13.0 mg. (controls) to 17.0 mg. (groups A and B, Table I). Under the same treatment but with copper sulphate the ovaries weighed 22.3 mg. (group C). In this group the distribution of the ovarian weights was more even throughout the range while in those without copper (group B) in only 2 cases were the weights above 24 mg. The median like the mean was higher in the copper treated group but the differences are small and not statistically significant. The mean difference divided by the standard error of the difference is only 1.7. One male rat pituitary gland is quite a minimal stimulus and positive vaginal smears are produced without much change in ovarian weight. This we have previously noted[1, 3] and it is evident here in groups A and B.

When the stimulus was doubled and 2 rat pituitary glands implanted in the body cavity, the ovaries were significantly larger than when only one pituitary was given (groups B and D). Here again copper was without effect, the medians being the same at 50 mg. each in the 2 groups and the means only slightly different (groups D and E). Thus, one may conclude that copper does not significantly change the reaction of the ovaries to pituitary implants when either the stimulus is minimal, as when one male rat pituitary gland is given, or when the stimulus is considerably above threshold.

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Experimental Alveolar Bone Atrophy Produced by Ascorbic Acid Deficiency and Its Relation to Pyorrhea Alveolaris.*

P. E. BOYLE, O. A. BESSEY AND S. B. WOLBACH.

From the Department of Operative Dentistry, Dental School, and the Department of Pathology, Medical School, Harvard University.

Vitamin C (ascorbic acid) has been characterized by Wolbach and Howe[1] as necessary for the production of intercellular substances. Failure of connective tissue cells to form collagen matrices adequately accounts for the clinical signs and pathology of scurvy.

[3] Emery, F. E., *et al.*, PROC. SOC. EXP. BIOL. AND MED., 1931, **29**, 42.

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[1] Wolbach, S. B., and Howe, P. R., *Arch. Path.*, 1926, **1**, 1.

Although loosening of the teeth of both man and animals in scurvy has been recognized,[2, 3] there has been little study reported of the pathological changes of the peridental tissue. The striking alterations in the tooth pulp and dentin have diverted attention from the peridental soft and calcified tissues.[4, 5] The influence of a chronic deficiency on these tissues has not been adequately described.

Pyorrhea is classified into two main types—(1) a local inflammatory process beginning at the gingival margin; (2) a systemic process characterized by diffuse atrophy of the alveolar bone.[6] Type II is recognized clinically by a loosening and wandering of the teeth, generalized rarefaction of the alveolar bone, and widening of the peridental membrane. Resorption of alveolar bone and cementum with loss of the collagenous fibers of the peridental membrane and depletion of the hematopoietic cells of the bone marrow are the essential microscopic findings. Pocket formation and suppuration are not characteristic of the early stages but may result from infection superimposed later in the disease process.[7]

Our findings in the peridental tissues of cases classified on a clinical basis as Type II pyorrhea corroborate those of Gottlieb.[6] Changes in the alveolar bone and peridental tissues are identical with those found in the peridental tissues in cases of unquestionable infantile scurvy[8] and with changes in animals maintained on diets deficient in ascorbic acid.

In the present study, a large number of guinea pigs have been kept for periods up to 6 months on a diet free of vitamin C, supplemented by measured amounts of ascorbic acid (0.3 to 5.0 mg. per diem), together with adequate controls. The head has been split in a sagittal plane, and X-rayed. Ground and decalcified sections in cross and in longitudinal planes, of both incisor and molar teeth and surrounding tissues, have been prepared.

The paradental tissues, in acute scurvy, are so weakened that the teeth may be easily extracted. Congestion of the gingiva is a constant finding, but pocket formation rarely occurs. X-ray and histological examination reveals a marked rarefaction of the alveolar bone and widening of the peridental membrane. These changes are

2 Westin, G., *Dent. Cosmos,* 1925, **67**, 868.

3 Hess, A. F., *Scurvy, Past and Present,* Philadelphia, 1920, J. B. Lippincott Co.

4 Hanke, M. T., *Diet and Dental Health,* Chicago, Ill., 1933, University of Chicago Press.

5 Höjer, J. A., *Acta Paediat.,* 1924, Supp. 3: 8.

6 Gottlieb, B. L., *J. Am. Dent. Assn.,* 1927, **14**, 2178.

7 Kronfeld, R., *Histopathology of the Teeth,* Philadelphia, 1933, Lea and Febiger.

8 Boyle, P. E., *J. Dent. Res.,* 1934, **24**, 172.

conspicuous over the labial enamel-covered part of the incisor teeth in the region anterior to the fulcrum of tooth movement. The failure of collagen-fiber formation which normally accompanies continuous eruption of the tooth results in weakening of the suspending apparatus. Ultimately the peridental fibers are unable to sustain the forces of mastication, the teeth become loosened, and atrophy of the bone results in the direction toward which pressure is exerted —(*i. e.*, toward the labial alveolar bone).

Similar changes take place at a slower rate in the tooth and peridental structures of animals on low ascorbic acid levels. The gross, X-ray, and histological deviation from normal depend upon the amount of ascorbic acid administered.

Thus in both acute and chronic ascorbic-acid deficiency, generalized rarefaction of the bone occurs. This rarefaction is a result of the inability of the osteoblastic cells to form bone matrix and is accompanied by a similar failure of the fibroblastic cells to form collagen fibers. The loosening and wandering of the teeth is an expression of the weakness of the bone and collagen-fiber suspending apparatus. The histological details of atrophy of the bony, fibrous, and hematopoietic tissues in the tooth and mandible are the classical changes of scurvy.[1, 9] Such atrophic changes likewise are the characteristic features of peridental disease of the diffuse alveolar bone atrophy type.

Ascorbic-acid determinations on the blood of a limited number of patients with peridental disease[10] by the use of a modification of a previously developed test[11] indicate a positive correlation between low ascorbic-acid blood levels and rarefaction of the alveolar bone not solely attributable to local inflammatory processes. This is consistent with the above evidence that suboptimal ascorbic-acid nutrition is the important factor in the production of the diffuse atrophy type of pyorrhea.

Summary. The essential characteristic of the diffuse atrophy type of pyorrhea *(pyorrhea alveolaris)*, which is an inability of the peridental tissue to withstand functional stress, has been reproduced in guinea pigs maintained on diets deficient in ascorbic acid. The histological details in bone and connective tissue of these scorbutic animals are identical with those found in human peridental disease of this type.

[9] Aschoff, L., and Koch, W., *Scorbut, Eine Pathologisch anatomische studie*, Jena, 1919, Gustav Fisher.

[10] Weisberger, D., and Bessey, O. A. Unpublished data.

[11] Bessey, O. A., and King, C. G., *J. Biol. Chem.*, 1933, **103**, 687.