VOL. IV NO. 2

The Angle Orthodontist

A magazine established by the co-workers of Edward H. Angle, in his memory . . . .

The Structure of the Suture*

FREDERICK B. NOYES, B.A., D.D.S.

Chicago, Illinois

For many years the author has been interested in the development of the human denture and its relation to the growth of the cranium and face. As the attention has more and more been directed to the relation of face and cranium in development, the function of the suture in growth and development has more and more attracted my attention.

About a year and a half ago I directed my research assistant, Miss Alta Kamnetz, in a survey of the literature for articles on the structure of the suture. She found four, all primarily macroscopic and dealing chiefly with premature closure or obliteration. There was very little in them about the structure of the suture. We went to the International Research Council for help and they sent back the same list of papers. Since that time, with the help of Dr. Isaac Schour, we have found three other papers or reports. The most important is Ziebe, 1933, *Zeitschrift fur Stomatologie,* pp. 29, 837, 906, 1070. These articles are concerned with the changes in forcibly widening the maxilla by application of mechanical force. The changes in the intermaxillary suture are described and pictured. They are of interest in this connection in showing the formation of bone on both sides of the suture as a result of the force applied to the teeth.

This preliminary study was undertaken to determine, first, whether a study of the structure of the suture would give any light on the role of the suture in development, and, second, whether by histologic examination it would be possible to determine that growth was or was not going on in that area, and, third, whether it would give any evidence as to the direction and character of the development.

*Read before the Ninth Annual Meeting of the Edward H. Angle Society of Orthodontia, October 24th, 1933.

From a dog killed for other experimental purposes a portion of the parietal suture was removed with a trephine. Figure 1 illustrates the position from which the specimen was obtained. The piece was fixed in formalin,

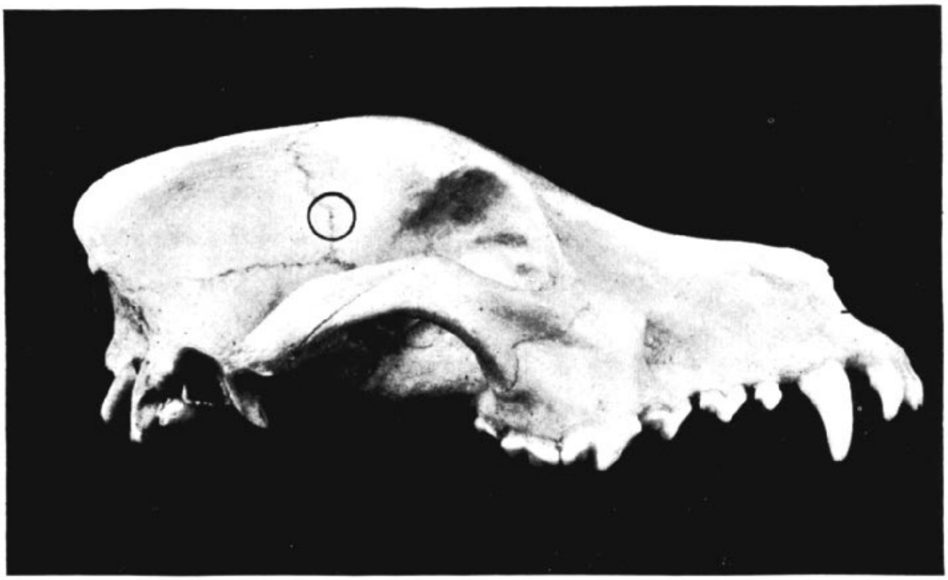

Figure 1. *Dog's skull showing position from which the material is taken.*

decalcified and half was sectioned at right angles to the surface and to the suture. The other half was sectioned parallel with the surface. Some sections were stained with haematoxylin and eosin and some sections with other stains for comparison.

It was found that the denticulate character of the suture is shown in both series of sections. It must be thought of, therefore, as a mechanism for increasing the area of surface for fibrous attachment between the two bones. It is evident that the suture acts as a "shock absorber" allowing a small amount of movement and adjustment between the bones united by it.

The similarity between the structure of the suture and that of the peridental membrane is most striking. In the peridental membrane the bundles of connective tissue fibers, which make up the bulk of the tissue, spring from the cementum, in which they are imbedded and calcified. They branch and anastomose, forming large or small bundles, passing around blood vessels and other structures, and are again imbedded in the bone of the alveolar process in small, compact bundles. At the surface of the tooth, cementoblasts are

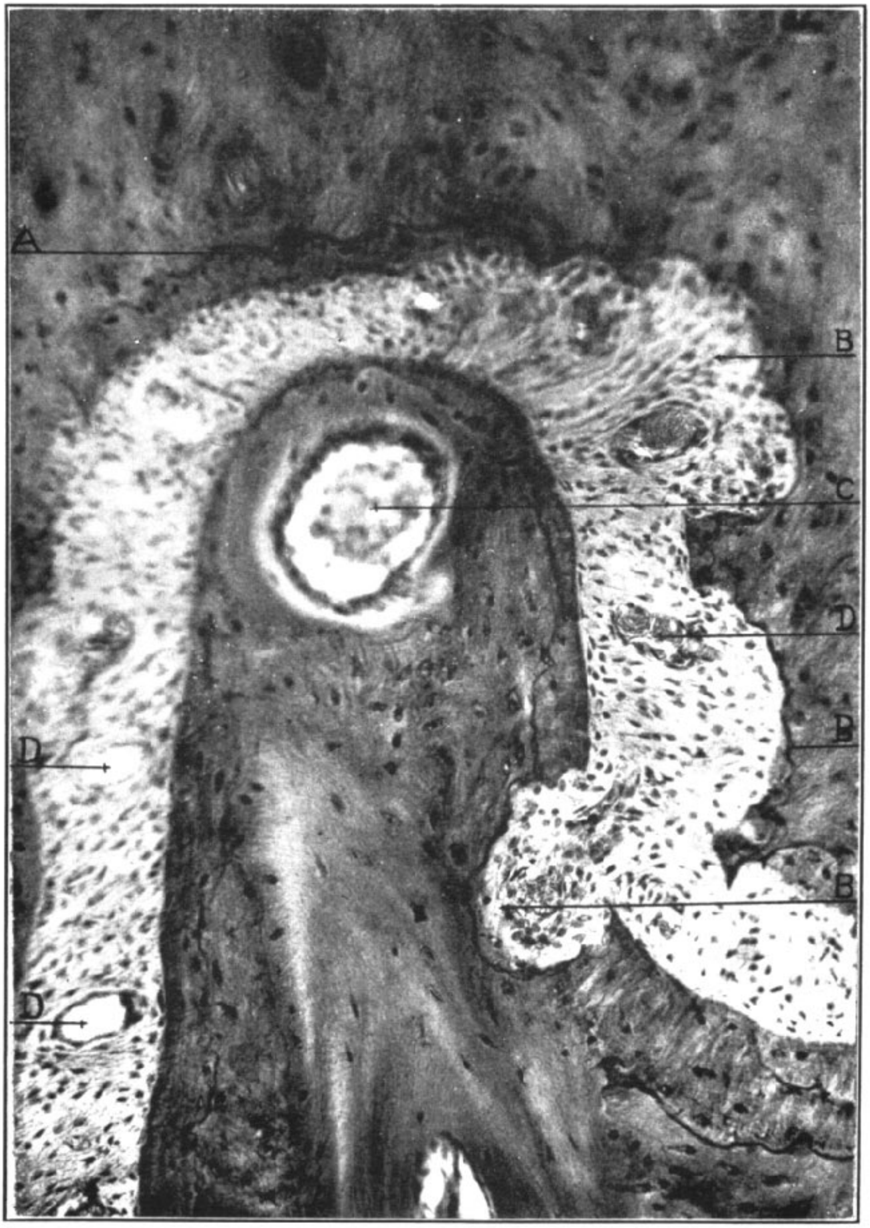

Figure 2. *Portion of the suture under low magnification.*

(a) Area of bone showing a record of absorption and slight rebuilding; (b) Bundle of white fibers; (b_1) Area of active absorption; (c) Formation of Haversian system bone; (d) Blood vessels.

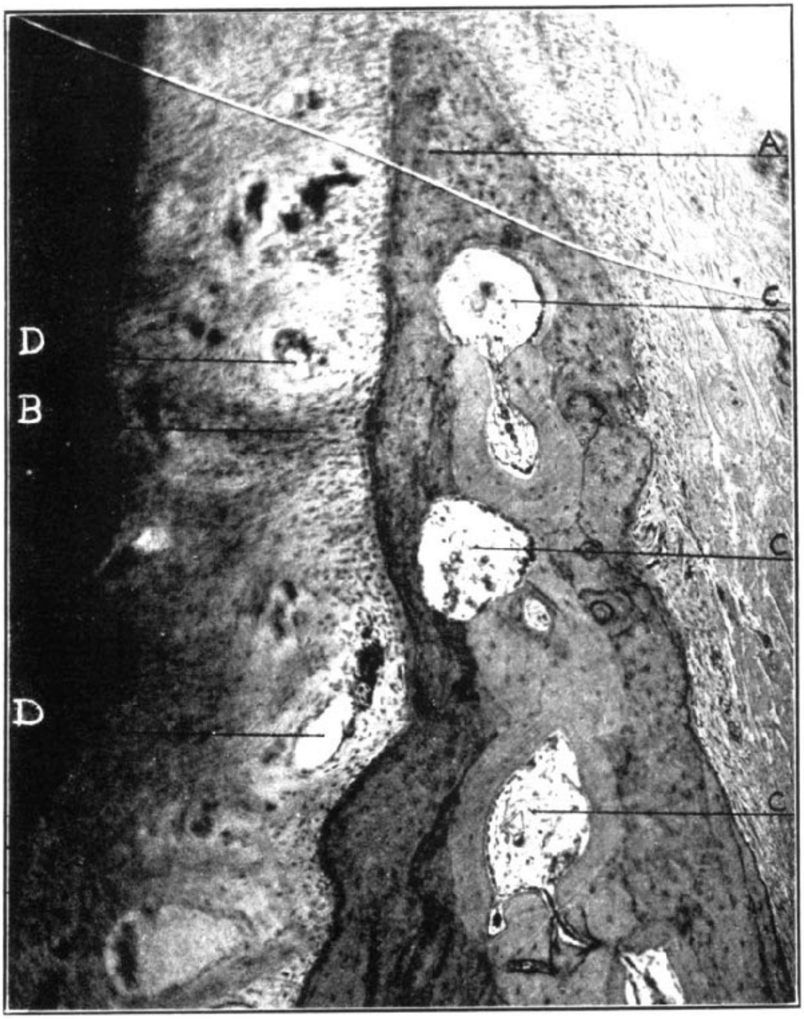

Figure 3. *Tip of alveolar process and peridental membrane.*
(a) Fiber bone; (b) Bundle of fibers of peridental membrane; (c) Formation of Haversian system bone replacing fiber bone; (d) Blood vessels.

found on the surface of the cementum between the fibers and, at the surface of the bone, osteoblasts are found between the fibers. Many fibroblasts are seen between the fibers, along their course. This description could be used almost word for word to describe the fibers of the suture except that they are inserted in the bone at both extremities. Given a limited field it would be almost impossible to tell whether it was peridental membrane or suture.

Figure 2 is a low power photomicrograph from the parietal suture. The connective tissue is made up almost entirely of white fibers which are imbedded in one bone, which branch and interlace as they pass across the suture and which are inserted in the opposite bone. This forms a continuous membrane separating the two bones. Blood vessels are numerous and are found between the fibers at about the center of the suture tissue. Entirely enclosed, as they are, in dense connective tissue they need little development of their walls which are characteristically thin, showing little or no indication of either media or adventitia. Many of them, although fairly large in diameter, show only an endothelial wall like a capillary. Fibroblasts are very numerous between the connective tissue fibers, and numerous osteoblasts can be found on the surfaces of both bones. Both bone surfaces also show the record of osteoclast absorption with only slight rebuildings, while in the finger-like projection of the opposing bone, formation seems to dominate. Notice specially at C the way in which the compact fiber bone is removed by absorption and reconstructed in Haversian system bone without imbedded fibers.

Figure 3 is a section cut parallel with the axis of a tooth through the tip of the alveolar process of a young sheep; we have almost exactly the same conditions on the peridental membrane side that are shown in Figure 2. The section does not lie flat and consequently the fibers and peridental membranes are out of focus but, even blurred, the similarity to the fibers of the suture are evident. Note especially the same mechanism of reconstruction of the fiber bone. This tooth and its alveolar process were growing rapidly occlusally. There was active growth of bone in the alveolar process especially at its tip but, as soon as a certain thickness has been produced, absorption is started which removes most of the fiber bone and then new Haversian systems are formed from these spaces.

Figure 4 is another field from the suture showing the imbedding of the fibers in the fiber bone and the absorption and replacement of fiber bone. Again, from the record of absorption and rebuilding, apparently the bone of the lower side is growing at the expense of the bone above, in this field.

Figure 4. *Low power view of the suture.*
(a) Record of absorption with slight rebuilding; (b) Formation of Haversian system bone replacing fiber bone; (c) Blood vessels.

Figure 5. *Higher power view of the suture.*

(a) Area showing absorption; (b) Formation of Haversian system bone replacing fiber bone; (c) Fiber bone; (d) Bundle of connective tissue fibers showing fibroblasts.

Figure 5 is a higher magnification of the tip of this projection. Note especially the character of the blood vessel wall, the imbedding and calcifying of the fibers, the fibroblasts and osteoclasts.

From the examination of these structures it is evident that the suture tissue contains all of the mechanisms for growth and adaptation; that as long as the two bones are separated by this membrane, changes in the relationship of the two bones can be accomplished by tissue changes in the suture. Growth may occur on the surfaces of both bones bordering the suture or on the surface of one bone or there may be developmental growth in one bone at the expense of the other bone, simply changing the position of the suture.

Summary

First, the structure of the suture is strikingly similar to the structure of the peridental membrane.

Second, the suture tissue contains all of the mechanisms for growth and development and this growth may be in any direction.

Third, histological examination of an area of a suture will show whether growth is active in this area or not.

BIBLIOGRAPHY

Schulz, M. Makroskopische Untersuchung an Schadeln, besonders der Kiefer, rachitischer Rattan. D. Monatschr f. 3. 51, 1933.

Ziebe, H. Die Verbreiterung des Oberkiefers durch mechanische Beeinflussung des medianen gaumennahtgewebes. Zeitmf. Stom. 1930, v. 28, 837, 906, 1070.

Polensky, R. Ein Versuch, auf histologischem Wege die Verbildung des rachitischen Rattenschadels zu erklaren. Dtsch. Monatschr. f. zahrblk. 1933, 51, 1920.

Weyhandt, W. Relation between brain and development of cranium. Revue Neurologique. Paris. 2:513. Oct. 1931.

Bronfenbrenner, A.M. Oxycephaly and allied skull deformities. Proceedings of the American Association for the study of the feebleminded. 56: 283-290, 1932.

Schultz, A. H. Metopic fontanelle, fissure and suture. American Journal of Anatomy. 44: 475-499. Nov. 1929.

Mijsberg, W. A. Function of sutures of growing cranium; problem of frontal suture and question of origin of abnormalities. Zeitschrift fur Morphologie und Anthropologie. Stuttgart. 30: 535-551. 1932.

Dwyer, H. L. Development defects of the skull: acrocephaly and anencephaly. Medical clinics of North America. 1923-24. 7: 1205-1209.