Some of the Observations of Dr. T. Wingate Todd on the Growth and Development of the Head and Face*

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Introduction

When the assignment was given to me last Spring to report on the contribution of Dr. T. Wingate Todd, relative to growth and development of the head and face, I was willing and ready to divide such a worthy task with any other member of the Mid-Western Group. Not too soon after starting the preparation, I was amazed to learn that there was no one else to share the task. Then and there I altered the title to "Some of the Observations," and felt that I could not give Doctor Todd, whom I know well and deeply respect, even a fair share of the tribute due him by a complete and worthy report in the ninety minutes allotted to me at that time. Hence, when a month or more ago, a note from Dr. Brodie said, "condense your Spring report down to twenty minutes," that was cause for further worry but I have tried to follow instructions and have reduced the material to the greatest degree possible.

The data selected is, I believe, of most interest and importance to us, and might well be selected by Doctor Todd himself, if he were before you in person. The following facts and opinions are those taken from his own papers and are presented entirely as such.

Fundamentals of Bone Growth

Considering the first fundamental, bone grows in an interstitial form, and is *constantly* changing its shape and proportion. It does not grow only under the periosteum or at the site of an epiphysial union. This fact is illustrated in histological specimens of the clavicle of fifty to sixty years of age as well as in young specimens. The head and face, also, are ever changing, particularly during childhood and adolescence, when the face swings from beneath the brain-case, opening the angle between the brain-case and the mask of the face. This is more marked in the anthropoid than in man. To John Hunter we owe the revelation that bone growth involves addition of structure, as well as abstraction of tissue.

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A Study of Defective Growth shows plainly two important facts: First, cranial growth is not uniform. It is localized here and there. Second, in order to permit this intermittent growth, there must be considerable adjustment, so that there are areas in which increase in dimension is predominant and other areas in which adjustment takes place between adjacent areas exhibiting various degrees of growth.

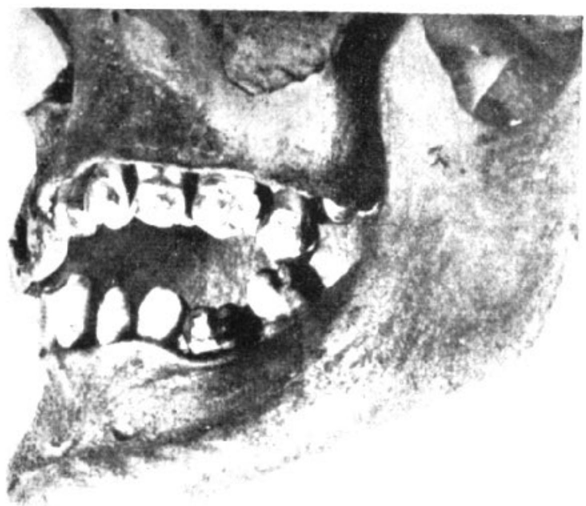


Figure 1

The following illustrations demonstrate this fact. Fig. No. 1 presents a defect in a male white adult, 27 years of age, of the left upper and lower buccal teeth, alveolar processes, and corresponding maxilla and mandible. In the upper, the deciduous cuspid and second molar are retained. The right side was not as severely involved. This is to be associated with a defect in the alveolar process. Fig. No. 2 shows a defect involving the entire face. This is an 18 year old, male white defective skull, (center), in which some permanent teeth had erupted. This appears with a normal 18 year old male white skull, (right), and also a skull of a 1 year old child, (left). The form resembles the infant skull, while the cranium is large and rounded and out of proportion to the face. The zygomas are overdeveloped and the jaws, while increased in size, still resemble the infant jaw, there being little angle to the mandible and no growth in the ramus.

These two illustrations show the constant change that bone presents in growth, addition and abstraction of substance, and it is sometimes an erratic dimensional increase in one area, with necessary adjustment of various adjacent parts.

Figure No. 3 shows the skull of an adult female, a microcephalic idiot (cranial capacity 340 cc. instead of 1340 cc. normal). Obvious adjustment occurred here to permit the fairly normal sized face and jaws to be present on such a small cranium.

Figure 2

Principles of Growth in the Mammalian Face

Two years' work by a colleague, Mr. F. P. Schweikher, on hyena skulls, shows by superposition of young skulls (half grown) on adult, in Fig. 4, that there are three areas of growth. These are the occipital region, the pre-maxillary region, and the last premolar area of the maxilla, or carnassial area. In this animal there is *no* change in the proportions of the face or cranium, as seen in the top figures, which shows comparison in size and similarity in skull contours. The middle figure indicates that the main growth has occurred in the frontal area of the cranium hafting mask to the brain-case, and also in premaxillary-maxillary region. The lowest figure shows a detailed comparison of identical areas to demonstrate actual localized growth. Thus we see the comparative stationary condition of the occiput, of the premaxilla and of the carnassial area after the skull is half grown. Thence, forward, there is an increase in dimension in the maxillary area, the coronal area and the lower orbital area, which all are sites of sutures.

Principles Upon Which the Human Dental Arch Is Built

Those research workers who point out degenerative changes in modern human dentitions cite the erratic character, the presence and size of third molars, small cuspids, anomalies of lateral incisors, and defects of occlusion. Dr. Todd disagrees here and points to defects of occlusion as having been a result of urbanization of our generation and the preceding one. The growing generation which has the advantages of adequate public health and social hygiene will not present this. The mandibular third molar may be absent, but it has not suffered in size. The upper third molar varies in size and is sometimes substituted by a paramolar. Small size in third molars is characteristic of lowest mammals, and the upper is smallest because it occludes only with the hind part of the lower molar. Increased

Fig. 4.—Left side of face. Skull W.R.U. B1411. Cast of skull of Basuto woman. Female, negro, 32 years old. Microcephaly. Cranial capacity 340 c.c. Large mask (face and palate) hafted to tiny cranium.

Figure 3

size in last molars in the elephant, pig, baboon and gorilla is not a primitive condition, but a very specialized one.

The cuspid is not for tearing flesh; it is for guiding the occlusion of long-jawed animals. Some fruit eaters, as the orang-outang, have long cuspids.

Anomalies of lateral incisors are due to proximity to the premaxillo-maxillary suture, whereby their dental rudiments may be split.

Figure No. 5 shows the relation between a change in dental pattern and a change in jaw form. These are mandibles of Marsupials from Australia, namely, bandicoots. Perameles, on the left, has a very primitive form of tooth pattern. In Thalacomys, on the right, the cheek teeth have become long crowned and rounded, with some cusps even absent. Note also the change in the forms of the jaws. These changes go hand-in-hand with changes in the shape of fixation or fitting of the jaws in the face.

The most striking contrasting feature of human and anthropoid dentition is the size and predominance of the first molar. It is the first permanent tooth in both species. In the human its size is of importance—five cusped and larger than the second molar, and larger than the second deciduous molar. Anthropoids are different. The earliest known, Propliopithecus by name, in the Oligocene Period; reveals teeth in the mandible that are not long. There is little projection of the canines and the premolars are like human teeth. The first and second molars are equal in size; the third molars are smaller, with cusps rounded and low. The important fact to be mentioned here is that the dental pattern in this mandible could easily be developed either into the human pattern, by increasing the first and decreasing the second molars in size by specialized function, or into the modern anthropoid, by increasing the size of the second and third molars.

[illegible] Analysis of growth of hyena skull by P. P. Schweikher. Superposition of [illegible] half grown, upon skull [illegible] adult. Arrows indicate comparable landmarks. Top figure shows general comparison of size. Middle figure [illegible] that [illegible] growth has occurred in frontal area of cranium halting mask to brain [illegible] in premaxillary-maxillary region. Lowest figure shows detailed comparison of [illegible] to demonstrate actual localized growth. [illegible]

Figure 4

From India, in a later period, Miocene, come certain fossils of the ape, Dryopithecus Cautelyi, Figure 6. Here is the long cuspid for increased jaw length. The first premolar has become somewhat like the cuspid in form, while the second is somewhat like the molar. The first molar resembles Propliopithecus, but the second and third are larger than first. These clear-cut and crystalline cusps and the secondarily enlarged second and third molars, are like those of the Gorilla. The other specimen on the left, taken from Dryopithecus Frickae, demonstrates these characteristics more emphatically. From these characteristics it is inferred that these two examples of Dryopithecus are close ancestors of the modern Gorilla. The long jaws

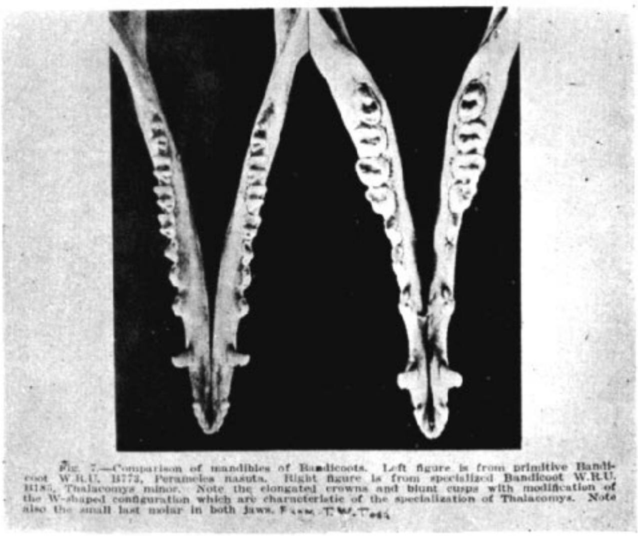


Figure 5

and the elongated second and third molars of the Gorilla are closely connected, and may both be the result of some common influence in molding the face.

Therefore, the human and anthropoid dentitions have developed from such a form as presented in Propliopithecus, the anthropoid pattern developing secondarily enlarged second and third molars and longer jaws, and the human emphasizing the larger first molar and short jaws.

The Antiquity of the Human Dental Arch

Types such as Pithecanthropus, or Piltdown Man, are not considered in the evolution of man's dentition, because Dr. Todd is not sure that fragments gathered under these names are really single individuals or even belong to creatures of the same kind. However, three specimens from the Old

Stone Age are considered. The young male mandible found at Le Maustier, France, one of many specimens of Paleolithic Man, is of the type called the Neanderthal Man. It presents crowded lower incisors and third molars smaller than other molars, and the dentition pattern is the same as modern man. This man lived 35,000 to 40,000 years ago. The last two generations, because of urbanization, following the industrial revolution, and accompanied by lack of proper hygiene and appreciation of the importance of the

Figure 6

first permanent molars, may show a stigmata of devolution which is false. The new generation should show a dentition that is equal to that of primitive man.

While the Broken Hill Man, from Rhodesia, presents a skull differing from modern man, yet his dentition is the same in form and size of teeth. The first molars are the largest molars as in man. The Heidelberg Man, of early Pleistocene Period, presents only a mandible, which, while large, engages modern sized teeth and about equally sized first and second molars. These present caries.

The dentitional type of modern man has been a fact probably since early glacial times, and while there is no known evidence showing relationship to Propliopithecus, the likeness indicates such.

Thus, we see also, that the so-called devolution of the human dentition is erroneous because the same symptoms, such as the small cuspid, crowded incisors, caries, and the large first molar, appeared in early known specimens likewise.

The General Program in the Development of the Jaws

While the mandible appears to be a simple bone, yet its growth is most complex and a study of it is made complex by virtue of the lack of sutures. The upper jaw presents a contrast in this regard. Long-jawed animals have been studied for the purpose of obtaining fundamentals which may apply to the human. The first of these is the Virginia Deer.

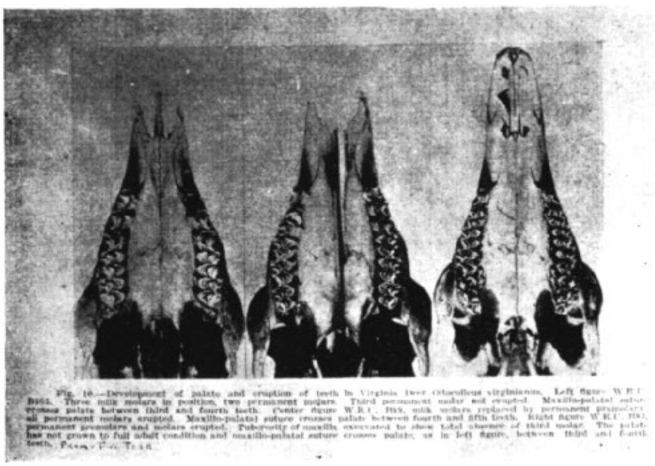


Figure 7

In Figure No. 7 the first skull shows the palato-maxillary suture reaching the alveolar process between the deciduous and permanent series (the third and fourth molars from the top, there being three deciduous and two permanent molars present). In the second skull the three permanent premolars have displaced the deciduous and three permanent molars are in place. The suture has now moved backward the width of the first molar. Conversely, the cheek teeth and process have moved forward, the palate bone acting as a stanchion for this progress. Thus, we see palatal growth with the eruption of the teeth. This is proved in the third skull where the suture is again between last premolar and first molar, as in the first skull, due to a lack of *presence or development* of the third molars, yet the second and third skulls are both adults in age.

Continued study of lower animals and mammals reveals that vascularization of bone, marked by multiple foramina, is the chief indication of activity in growth and repair. This is illustrated in the mandible of the Chimpanzee at the area of third molar eruption, and in the alveolar processes, after the removal of teeth.

In Figure No. 8, from the upper jaw of the Chimpanzee, is illustrated the fact that in the hard palate, the area of growth is mainly confined to the palatal processes of the maxillae. There is some activity in the premaxillae, but none in the palate bone. Premaxillary activity, in the adult Chimpanzee and in other animals, such as the Gibbon, Cow and Sheep, is due to the peculiar loose setting and the functions of the incisor teeth.

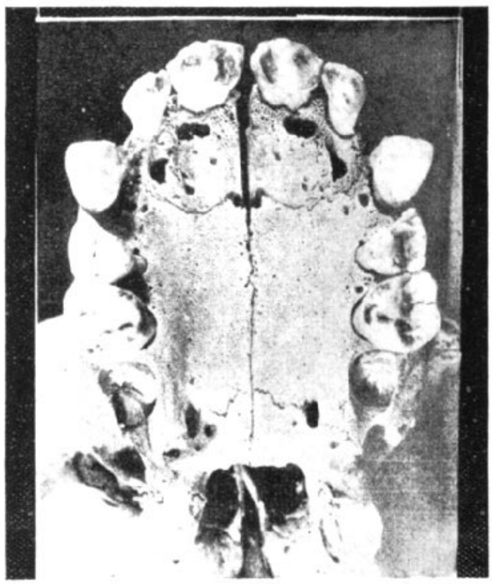


Figure 8

In Figure No. 9, superimposition of maxillae of young and adult female grey howlers (Alouatta Palliata—Costa Rica) on the first permanent molar areas, shows that the total distance occupied by the deciduous canine, three deciduous molars and the first permanent molar, is exactly the same as the distance occupied by the permanent canine, three premolars and the first permanent molar. The palate grows in length, however, entirely for the implacement of the second and third permanent molars and, as the vascularity of bone in the previous illustration showed, the growth is in the maxillary element, with very little in the premaxillary and none in the palatal element.

Reason is here given for study of lower forms than man, namely, because the elucidation of many growth factors are common to both and more clearly demonstrated in the animal because certain phases are simpler.

In a later paper, Dr. Todd discusses "Hereditary and Environmental Factors in Facial Development."

From the Cornell University Experimental Farm were obtained nine pairs of twin sheep skulls. One of each pair was thyroidectomized at between one and three months of age; their twin was used as a control for normal growth. Accurate study and deductions were made to determine the phases of normal growth and of defective growth. Individual differences in well-nurtured growing sheep are negligible. I am not going into the detail of the various aspects of development that this normal series showed, but Figure No. 10, showing the superposition of twin sheep skulls, in which the smaller one was thyroidectomized at thirty-five days, is very interesting. In one month the brain-case was almost complete, so consequent change is not noticed. Tooth eruption is delayed, but there is no effect upon the order of eruption or the form of the teeth. There is a marked defect in the canine region of maxilla, with up-curving of the hard palate. Growth defects of the frontal and nasal bones and the frontal processes of the maxillae effect the respiratory region. There is little defect in the hafting zone (deeper orbit and palato-pterygoid) and none in the brain-case proper. As there was no defect in mandibular growth, there was eventually a marked protrusion of mandibular incisors. Growth is progressive, not static.

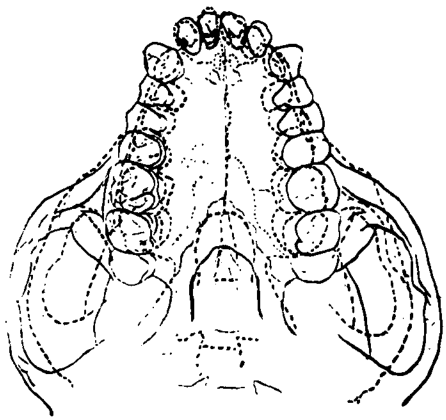
One of the sheep, thyroidectomized at forty-two days, was given thyroxin treatments two months later to restore physiological normality, and lived to twenty-two months. This skull then showed a maxillary growth equal to the seven months' stage and tooth eruption at the eleventh month stage. while the snout remained at a three to four months' stage.

A most important lesson here is the fact that if the date for certain expressions of developmental growth has gone, these certain expressions of developmental growth are *eliminated,* and while adjustments are made, defects occur that are permanent.

This teaches us that growth in dimensions is not uniform and continuous, but local and discontinuous. The time schedule, when interrupted, disallows certain areas to increase, and thus a permanent defect occurs, despite attempts at adjustment.

General Principles of Human Growth

In development and growth, there is more than increase in dimension. There is adjustment of parts to suit local increase, and thus there is change of proportion. Growth, then, may be termed increase in dimension, while development is change in proportion and adjustment of parts. There have been many observations in growth, but we, in Orthodontia, are mainly interested in development—change of proportion—adjustment of parts. There has been no criteria, we have only recorded growth in dimension and chronological time, and arrived at averages. Growth occurring under optimum conditions is the necessary thing to know. A roentgenographic technique, developed by Dr. Todd at Reserve, for the purpose of assessing develop-



Superposition of young and adult female gray howlers. Alouatta palliata, Costa Rica. W. R. U., B. 339 and B. 607. Note that the dental arch from the canine to the first permanent molar. and including both, does not change in size with growth. The extension exists for the second and third molars. From Dr. Todd

Figure 9

mental progress of the skeleton, was adopted by the White House Conference of 1930, for the study of skeletal growth and development. Real measures of developmental progress are expressed in appearance of ossification centers, penetration of cartilaginous epiphyses by bone and final union of epiphyses with bone shafts. These are not affected by heredity, whereas increase in dimension may be. Thus, if a child shows adequate developmental progress, failure to maintain average progress in dimensional increase may be discounted as of secondary and possibly of hereditary significance.

A spurt of growth during convalescence may and can make up for the interruption of growth in the growing child. If this does not occur, maladjustment of facial growth follows, and the orthodontist is needed later in childhood.

A few words about Dr. Todd—an Anthropologist—an Anatomist—a Teacher—and a Researcher. Oddly enough, this outstanding leader in the research field of child growth and development, started his medical career in pediatrics. After many years of separation from that specialty, he has again, recently, attained one of his fondest ambitions, that of helping to educate children and parents in intelligent developmental growth. He now holds the Chair of Anatomy at the School of Medicine, Western Reserve University, and, as Director of the Brush Foundation, which fosters healthy developmental growth in children, is directly responsible for the combined

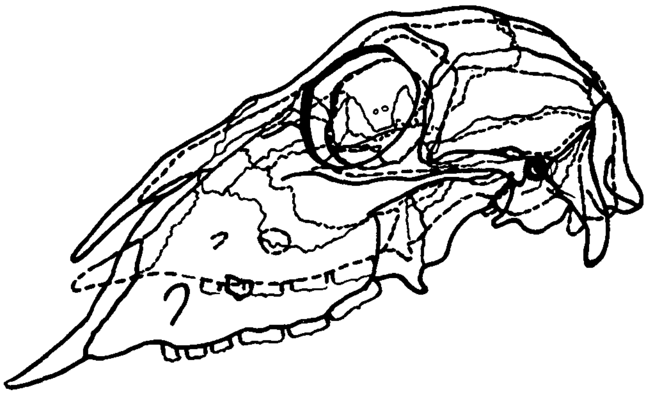


Fig. 1.—Superposition of twin sheep skulls twenty-four months of age. W. R. U. B1128, B1129. The smaller and defective skull (B1129) is that of a cretin, thyroidectomized at thirty-five days of age and showing a contracted snout and inhibited facial growth resulting from the experimental interference.

Figure 10

studies in the many phases of child growth and development that are now going on.

Regarding the future of the Study of Growth and Development of the Head and Face, at Western Reserve, I quote Dr. Todd directly, in regard to one of our fellow-members, of whom we are justly proud, because of his tireless efforts in his search for scientific facts. "To Dr. Broadbent, as Director of the Bolton Study, passes the responsibility of carrying on the intensive investigation of Facial and Dental Growth in Children . . . . Such mantle as I have had, I throw over his shoulders, though even now that mantle has shrunk to but a scantling through the vigorous growth of the orthodontic shoulders upon which it has fallen."

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