Anthropological Studies in Dental Caries

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J DENT RES 1943; 22; 267
DOI: 10.1177/00220345430220040501

ANTHROPOLOGICAL STUDIES IN DENTAL CARIES[1]

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The great prevalence of dental caries among modern civilized peoples is a matter of record. The disease begins early in life, and statistical studies have established the unwelcome fact that almost every school child is subject to it. It is also known that ancient peoples and primitive races suffered less from this ailment. However, investigations here have not been as thorough. Statistical studies have not been made.

As a result, many leading scientists tend to express extreme views on this subject. Thus, only recently, Merritt (1), stated as follows: "No one knows the cause of the two most universal dental ailments, namely, tooth decay and pyorrhea. . . . It is known that primitive man suffered from neither of these affections." A contrary view is presented by Weinberger (2), who states: "That we are dealing with new problems, generally believed to be the result of modified conditions brought about through modern civilization, is not a fact, for ancient man, physically, in some respects, was very much as man of today. There is sufficient evidence to show that he suffered from caries as well as abnormalities in the position and irregularities of the teeth, and that unerupted, supernumerary, retained and impacted teeth date back to the earliest remains of the human type." Evidently, such contradictory and irreconcilable statements by two dental scientists not only fail to clarify matters, but tend to further befog the issue, and leave us floundering in a mist of uncertainty on a very important subject.

What is the true status of caries in primitive man? Was he immune or partly immune to the disease? If so, what was the mechanism of this immunity? To find appropriate answers to these questions, we have gone directly to the original subject matter. We have undertaken anthropological studies of dental caries in skull collections of various racial stocks. Our findings are presented in this paper.

OBJECT AND METHOD

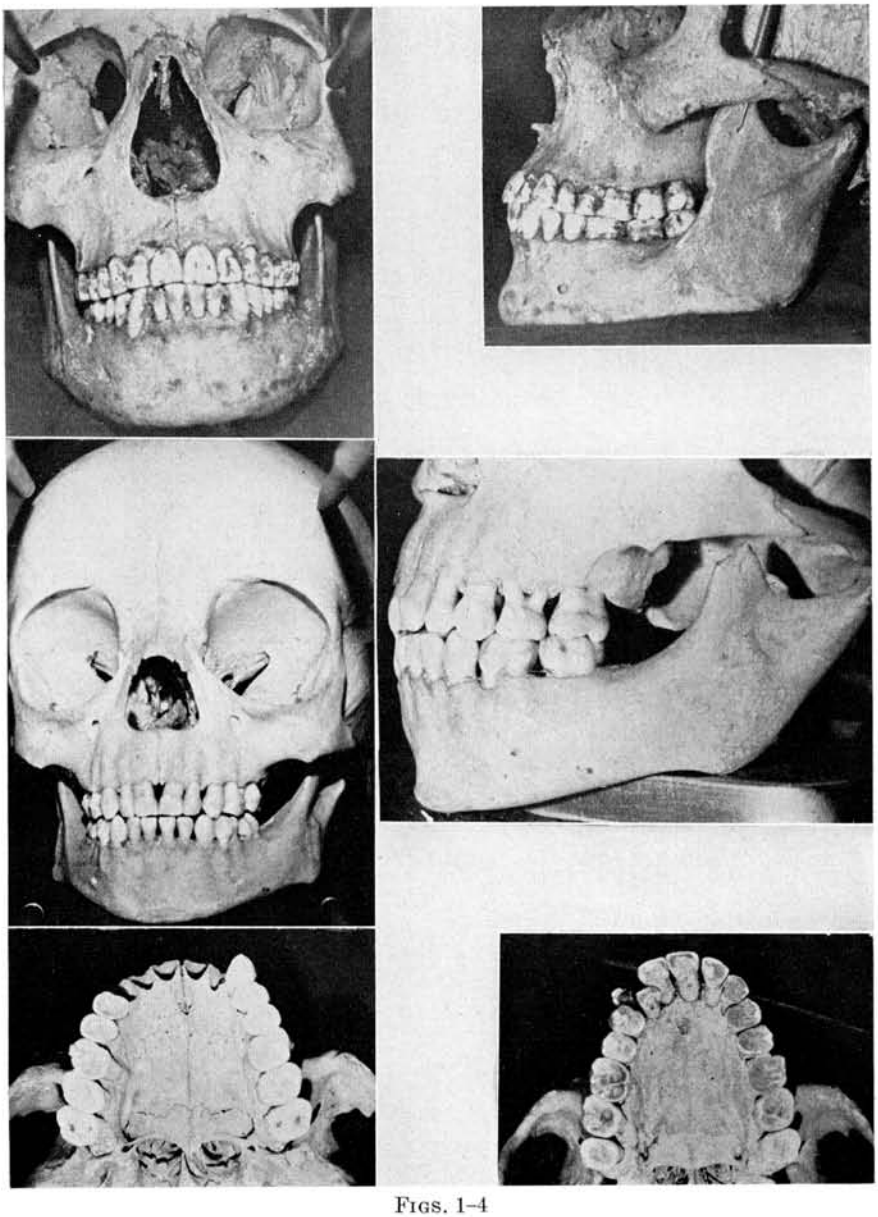
The anthropological division of the American Museum of Natural History in New York contains one of the richest skull collections in the world. Various races and nationalities, and peoples of all continents and diverse eras find representation in this collection. Those skulls that were unearthed in the same geographical area are grouped together. Our study includes 46 of these geographical groups containing approximately 4,000 skulls.

[1] Presented at a meeting of the New York Section of the International Association for Dental Research, December 28, 1942, and by title, at the 21st General Meeting of the I.A.D.R., Chicago, March 13 and 14, 1943 (*J. D. Res.*, **22**: 225, 1943). Received for publication March 30, 1943, revised April 22, 1943.

TABLE I

Caries incidence in 46 geographic groups

NAME OF GEOGRAPHIC GROUP	NO. OF SKULLS	NO. OF TEETH	NO. OF CARIOUS TEETH	PERCENTAGE OF CARIOUS TEETH
New Zealand	49	399	9	2.2
Solomon Islands	32	139	1	0.7
Tahiti	35	145	2	1.3
Easter Island	43	235	9	3.8
Hawaii	12	188	—	—
Chatham Island	21	199	—	—
New Britain, Ralum	130	1859	8	0.4
New Guinea	30	281	1	0.3
Egypt, Giseh	69	356	14	3.9
Egypt, Nubia	10	58	2	3.4
Egypt, El Hessa	137	1805	82	4.5
West Africa	20	364	4	1.1
South Africa	35	732	7	0.9
China	53	464	24	5.0
India	91	1901	33	1.7
Japan & Korea	23	362	10	2.7
Malay Peninsula	91	450	20	4.4
Mongolia	22	78	4	5.1
Siam	36	278	19	6.8
Siberia	10	76	—	—
Asia Minor	269	1211	52	4.3
Hungary	178	2446	216	8.8
Italy	14	130	11	8.4
Yugo-Slavia	68	109	37	34.0
Poland	15	87	8	9.1
Russia	37	306	11	3.5
Greece	108	378	24	6.3
Germany	91	745	164	22.0
Austria	166	692	64	9.2
Honduras	10	143	8	5.5
Porto Rico	28	544	23	4.2
Venezuela	14	176	17	9.6
Peru	232	1867	152	8.1
Colombia	12	230	6	2.6
Bolivia	135	659	17	2.6
Chile	26	363	14	3.8
Patagonia	27	125	—	—
Mexico	346	3298	153	4.6
Eskimo	255	1974	—	—
British Columbia	337	3077	—	—
Oregon	61	444	5	1.1
Washington	182	1979	18	0.9
Utah	148	1699	77	4.6
New Mexico	208	3246	127	3.9
California	30	438	7	1.6
Alaska & Aleutians	45	565	2	0.4



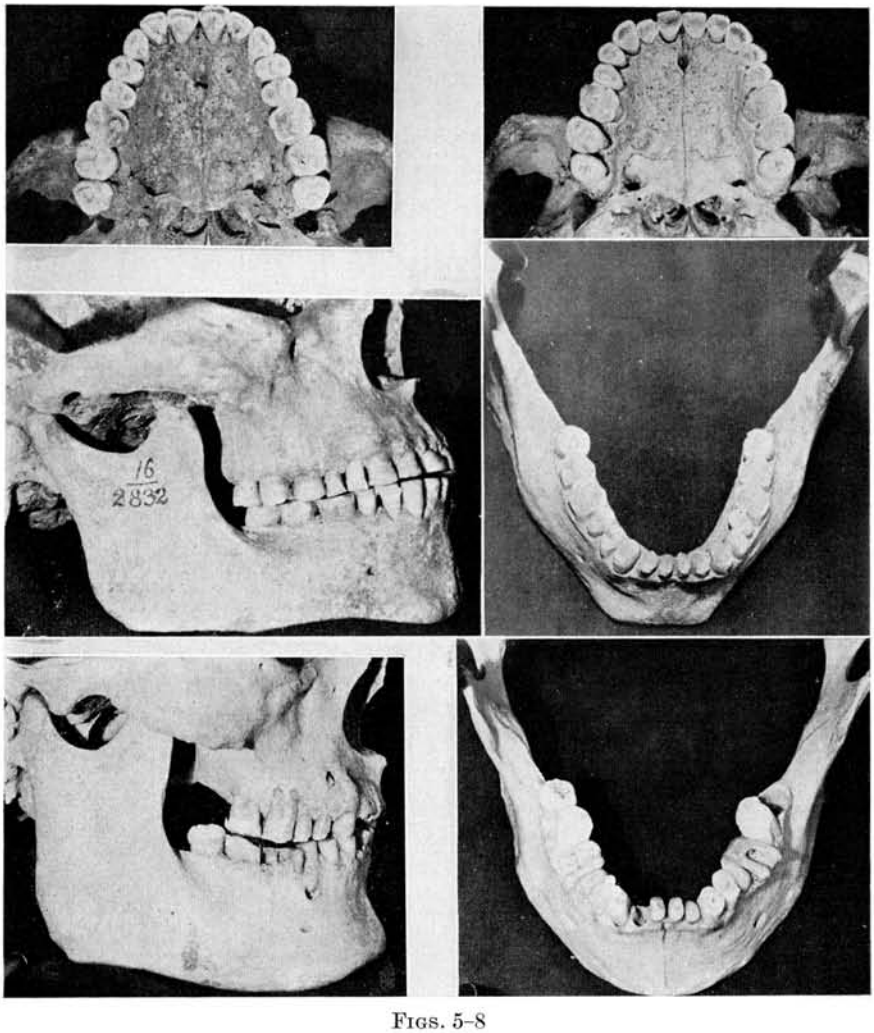
FIGS. 1–4

FIGS. 1a (upper left) & 1b (upper right). El Hessa, Egypt, #3111. Anterior and lateral views of ancient Egyptian skull, demonstrating features observed in most primitive jaws. Note full complement of teeth, well articulated and in functional stage of attrition. Prominent zygomatic arches and rugged character of maxillary and mandibular bones bespeak powerful and vigorous function.

FIGS. 2a (middle left) & 2b (middle right). Siberia, #7777. Anterior and lateral views of deciduous dentition in primitive 3 year old child. Note prominent zygomatic arch, flaring ramus, and rugged angle of mandible where masseter muscle attaches.

FIG. 3 (lower left). Russia, #3591. Palatal view, showing caries only on third molars, which have functioned least.

FIG. 4 (lower right). New Britain, #1518. Palatal view, showing all teeth well worn and free of dental caries, except for malposed right second incisor and canine. Extensive decay here is due to local food retention and stagnation.



FIGS. 5–8

FIG. 5 (upper left). Washington, #22171. Palate of American Indian, with teeth showing advanced physiologic attrition.

FIG. 6 (upper right). Eskimo, #100. Sturdy, square palate, with transitory stage of attrition registered on all teeth except third molars.

FIGS. 7a (middle left) & 7b (middle right). British Columbia, #2832. Lateral view of articulated skull and anterior view of mandible, showing transitory stage of attrition, with obliteration of occlusal anatomy and wear extending well into dentin.

FIGS. 8a (lower left) & 8b (lower right). New Zealand, #783. Lateral view of articulated skull and anterior view of mandible, showing teeth in senile stage of attrition, with wear past proximal contacts and exposure of pulps, despite the laying down of secondary dentin. Note periapical abscesses at L.R.5 and U.R.4.

These photographs were taken with the kind permission of the American Museum of Natural History, New York, N. Y.

Our first objective was to establish statistically the incidence of caries within each of these geographical groups. We counted the number of teeth remaining in each skull, and carefully examined each tooth for caries. Then the percentage of carious teeth was computed for the group. Many teeth were found to have been broken or lost from the jaws after death. In establishing the caries index of a live subject, filled, crowned, and missing teeth are usually attributed to an advanced carious lesion, and a factor is added to the total number of carious surfaces. Because of the factor of posthumous damage to the skulls, it was decided to ignore all missing and fractured teeth in the count. Only the 38,300 unbroken teeth actually found in or with the skulls were included in the statistical studies. No dental restorations were found in the ancient and primitive groups studied.

Our second object was to search for possible reasons why certain individual skulls or groups of skulls were more susceptible to dental caries than others. Special attention was paid to the state of development of the jaw bones and the various points which serve as the origin and insertion for the muscles of mastication. The shape of the palate was noted; the anatomy of individual teeth was studied, with particular attention paid to the presence and extent of attrition.

A statistical summary of our findings is given in Table I.

STATISTICAL FINDINGS

Examination of Table I reveals that, of the 46 groups examined, 6 were completely caries free. The Eskimo group, with 255 skulls and 1974 teeth, and British Columbia, with 337 skulls and 3077 teeth, are fairly large collections and are representative enough to warrant the conclusion that these peoples were immune to caries. The other four groups—Hawaii with 12 skulls and 188 teeth; Chatham Island, 21 skulls and 199 teeth; Siberia, 10 skulls and 76 teeth; and Patagonia, 27 skulls and 125 teeth—are too small to be representative. All of the 40 other groups showed various degrees of caries, ranging from 0.3% in the New Guinea group to 34% in the Yugo-Slav group.

The most ancient skulls represented in the collection came from Egypt. Of these, there was 3.9% caries incidence in the Giseh group; 3.4% in Nubia; and 4.5% in El Hessa. The relatively high state of civilization achieved in ancient Egypt may be a consideration here.

The general tendency in the groups studied was for a lower incidence of caries in the ancient and primitive peoples, increasing in the modern and civilized groups. All primitive peoples were not immune to caries.

DISCUSSION

The fundamental chain of factors required to initiate a carious lesion is as follows: Acid forming microorganisms collect in sheltered areas, such as the interproximal spaces or occlusal pits and fissures. They are protected from the saliva by plaque formations, and are nourished by carbohydrate food residues. Their metabolic products are acids which dissolve away tooth structure. In order to prevent caries, this chain must be broken. We believe that this is best

accomplished by proper mastication. The teeth of the primitives needed no artificial methods of cleansing. The mouths of these peoples were naturally clean. The anatomy of sound, healthy teeth and soft tissues is such that food particles could not adhere and stagnate. Gingival tissues of good tone and contour probably completely filled the interproximal spaces up to the firm proximal contacts. Natural, coarse, fibrous, detergent foods, vigorously chewed, swept clear the fissures and sluiceways of occlusal anatomy. It was the forceful and thorough mastication of detergent foods that gave primitive groups their caries freedom.

With the advance of civilization, the human brain has devised mechanical aids and refinements to ease the physical tasks of the body. Important in this respect is the development of the culinary art. Modern foods are cooked, boiled, baked, cut, chopped, and mashed into sophisticated forms. Their soft, sticky consistency causes them to adhere to the teeth. They lack the coarse particles and rough fibers which cleanse the teeth during mastication and lack the ability to stimulate more than a minimum of masticatory function.

Biologists know that it is function that determines structure. Thus, the degree of masticatory function is reflected in the anatomy and contour of the bones which serve as origin and insertion for the muscles of mastication. In a primitive skull that has developed with vigorous masticatory function, prominent zygomatic arch, a square, heavy mandible with forceful ridges and broad sulci for muscle attachments are found. The palate is broad and square, the alveolar process rugged, and the occlusion even. The teeth also show the marks of thorough, powerful functioning. A physiologic state of attrition has been achieved, and dental caries is minimal or absent.

The importance of lack of masticatory function as a cause for caries is emphasized by our observation of some skulls in which all teeth were caries free with the exception of the third molars. The latter teeth showed no attrition, since they were not quite reached by the food and functioned less than the rest. Another example is where malposed teeth created a food trap in which an advanced carious lesion developed. There is nothing mysterious about the caries freedom of the other teeth in those jaws. They were not immune by virtue of complex antigen-antibody reaction. They were merely properly aligned and kept mechanically clean by proper function.

That the masticatory apparatus of primitive man functioned better than that of modern man is attested to not only by the general anatomy of the skulls but also by the degree of attrition registered on their teeth. Attrition is the gradual wearing away of the hard structure of the tooth through the physical and physiologic agencies of food mastication. During function, the morsal surfaces of the teeth gradually yield some of their substance to the friction of the food and of one surface against the other. Attrition is a slow process, constantly advancing with age.

On a previous occasion one of us (M. K.) dealt with this subject in more detail. We pointed out that dental attrition is not a pathological but a physiological phenomenon, resulting from the natural functional process of food mastica-

tion (3). Attrition was divided into three stages: the physiologic stage, where only the enamel shows wear; the transitory stage, when a substantial amount of dentin is lost; and the senile stage, when the proximal contacts are lost and the pulps are exposed and devitalized. The rapidity of the course of attrition depends mainly upon the amount of function to which the teeth are subjected in the process of mastication, and upon the physical nature of the food consumed. Hard, bulky, resistant foods, which demand greater pressure and exercise of the masticatory apparatus, wear the teeth more rapidly than liquid, soft, resistless foods. Very little attrition is found in modern, civilized man; but attrition is characteristic of the teeth of ancient, uncivilized and primitive peoples. In the latter, dental attrition starts early in life. Even the teeth of young subjects show distinct evidence of wear.

In the physiologic stage of attrition, the teeth and supporting structures are in a perfectly healthy state, showing no caries or other ailments. The senile stage, on the other hand, is usually accompanied by bone destruction, periapical osteitis, peridontosis, and root caries. Caries, at this stage, may be induced by the wedging of food between the teeth due to the loss of proximal contacts.

There can be no attrition without function. Therefore attrition is the index of function; it is the yardstick by which masticatory function can be measured. In the examination of skull collections, attrition serves as a guide in determining the degree in which the masticatory apparatus functioned during the life of each individual. Our investigation shows an inverse proportion between masticatory function and the incidence of dental caries.

At the present moment, when the incidence of caries is assuming larger and more alarming proportions among modern, civilized communities, we must pose the very pertinent question: Is it lack of function of the masticatory apparatus which is mainly responsible for this deplorable condition? Our answer is in the affirmative.

SUMMARY AND CONCLUSION

The incidence of dental caries among various peoples of diverse periods was investigated. 4,000 skulls and 38,300 teeth were examined. Of the 46 geographical groups, 6 showed no caries. The more primitive groups tended to have a lower incidence of dental decay than the more modern and civilized peoples. Anatomic studies of the masticatory apparatus of all the groups show that the jaw bones of the primitives were better developed and the teeth evinced greater attrition than those of modern peoples. This attests to the higher degree of function of the masticatory apparatus of these races. There is an inverse proportion between masticatory function and the incidence of dental caries. Lack of dental function is an important factor in the causation of caries among modern peoples.

We are grateful to Dr. H. L. Shapiro, Curator, and Miss Bella Weitzner, Associate Curator of the American Museum of Natural History for the kind assistance and invaluable advice which made these studies possible

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