Section of Odontology

President W E Herbert FDS RCS

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Paper

Assessment of the Ages of a Population of Anglo-Saxons from Their Dentitions[1]

by Professor A E W Miles FDS
(*Department of Dental Histology & Pathology, London Hospital Medical College, London*)

Ever since 1949 the Odontological Museum has possessed the skeletal remains of 20 individuals excavated at an Anglo-Saxon burial site at Breedon-on-the-Hill in Leicestershire (Kenyon 1950). They were presented by Dr Kathleen M Kenyon who directed the excavations. Over the period 1950–1955 the skulls of a further 150 or so individuals were systematically recovered from the same site by Mr D R Brothwell, now of the British Museum (Natural History). Owing to circumstances associated with advancing quarrying operations it was not possible to recover the post-cranial skeletons. Thanks to the kindness of Mr Brothwell, who has allowed these additional Anglo-Saxon skulls to be at least temporarily housed in the Odontological Museum, I have been able to study the whole collection which consists of the skulls or parts of the skulls of nearly 190 individuals, and which might be regarded as a more or less random sample of those people who lived and died in this Anglo-Saxon settlement about the period A.D. 700–900.

In order to try to learn something about these people and to get some idea of the age-at-death distribution in such a population, I have attempted to assess the ages of all the exhumed individuals by using tooth attrition in a more systematic fashion than appears to have been done hitherto.

There is no reliable way of assessing the age from skeletal remains, except in the case of young subjects while the epiphyses remain ununited or while the dentition is immature. The state of the cranial sutures, of the symphysis pubis and of various features of the clavicle and scapula have often been employed, but it is generally acknowledged that these criteria give only very approximate and unreliable estimates of age (Brooks 1955).

Wear of the teeth is a continuous process and is probably fairly constant in rate in any group of people of closely similar dietary habit. It would seem likely to be more continuous than and at least as likely to affect all individuals equally as the processes responsible for the bony changes which provide the only other means of assessing individual age from skeletal remains.

Wear of the teeth is a conspicuous feature of the Anglo-Saxon dentition, though probably no more so than is common in early peoples and in those living under simple agrarian conditions. Detailed comparisons of the rates of wear in different peoples do not appear to be recorded and indeed could in general only be made from a study of specimens with immature dentitions or which otherwise could be aged with accuracy. The rate of wear of the Anglo-Saxon dentition appears to be similar to that in ancient Greeks, as described by Phillipas (1952), but less than that met with in the Australian aborigines (Nicholls 1914) and Eskimo (Pedersen 1949).

It is usual to attribute the greater degrees of tooth wear to the nature of the food; namely to food of fibrous or tough character requiring much chewing, or to contamination of food with abrasive substances such as sand, soil or ashes. Quite apart from these considerations, however, chewing habits and conventions in early times are likely to have been quite different from those of the present day. Those living less sophisticated lives, with few man-made pleasures, both in the past and the present time, would be inclined to spend more time savouring the act of mastication. This could lead to increased wear in the same way that habitual tooth grinding, as a nervous habit, leads to marked wear of the teeth.

[1]A more complete account of this work is to be published in 'Dental Anthropology' (Ed D R Brothwell) *Symposia of the Society for the Study of Human Biology*, Vol. 5. Oxford, 1962

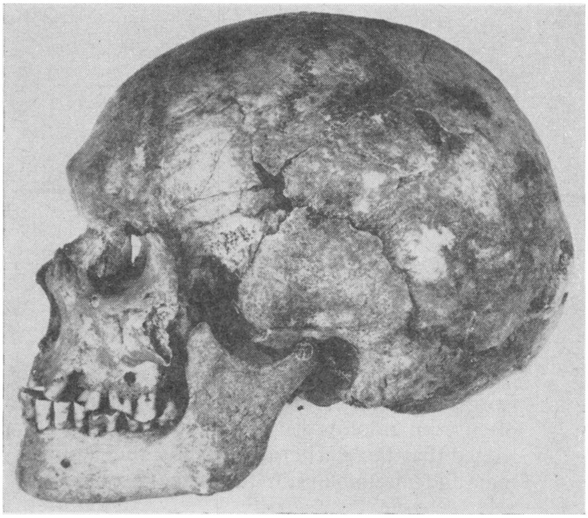

Fig 1 *Lateral view of one of the better preserved skulls (B.70)*

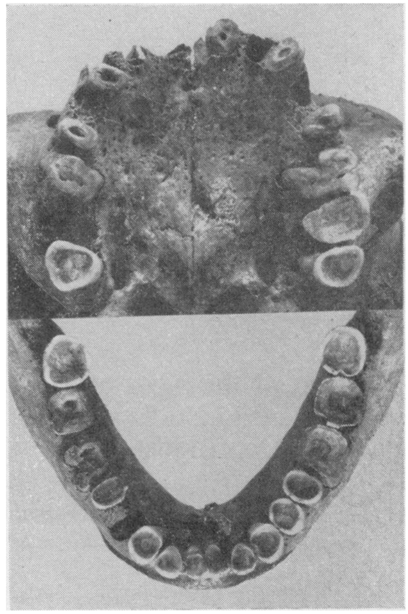

Fig 2 *The dentition of the same skull. There has been ante-mortem loss of some teeth and the pulp cavities of several are exposed by wear. Most of the enamel has been worn from the occlusal surfaces of M_3. Age was estimated to be 55 years*

Little information is available concerning the details of the Anglo-Saxon diet, but meat from the chase or domesticated animals and fish, in winter dried or salted, nuts and fruits from the forests or cultivations, and of course bread, were the important items. Bread was made from a meal of relatively coarse character, generally hand ground in stone querns and probably containing a high proportion of barley or rye (Blair 1956).

About one-half of the Breedon skulls have reasonably complete dentitions and of these 32 are of young subjects with immature dentitions. An example of one of the older and more intact skulls is shown in Figs 1 & 2. It would be hard to say whether this person was as young as 40 years or as old as 60.

The plan of approach was to try to establish the rate of wear of the teeth from a study of the young skulls of which the age could be assessed from the state of development of the dentitions, and so to acquire data which could form a basis from which, by extrapolation, the ages of the older subjects could be estimated. The ages of the dentally immature specimens were accordingly estimated, making use solely of the state of development of the dentitions in relation to the Schour & Massler chart (1941) modified slightly to take the works of Gleiser & Hunt (1955) and Garn *et al.* (1959). For the assessment of the ages of those dentitions which had advanced beyond the state of commencement of the formation of the roots of the third molars (M_3), which is not provided for in the Schour & Massler chart, some data collected from present-day subjects were used. Providing the assumption is made that the chronology of tooth development was similar for these Anglo-Saxon people as at the present time, this group of 32 skulls can be regarded as a group of subjects of known ages. By good fortune the skulls were evenly distributed in age and there were roughly two for every year.

When the skulls were arranged in age order, it became evident that wear of the occlusal surfaces of the molars progressed in an orderly fashion through the range. Stages of polishing of the cusps were followed by the appearance of facets which increased in number and size according to a fairly regular pattern. Then small islands of dentine appeared at the tops of cusps and gradually increased in size. Attention has been concentrated on the molar part of the dentition and observations on wear in other regions have been confined to noting that premolar wear corresponds closely with molar wear, but incisor wear is much more variable.

This series of skulls of 'known age' ranging from 6 years to 18 or 19 years showed the functional life of M_1 from the time it erupted at about 6 years to the end of its first twelve years of functional age. In the case of the second molar (M_2) it showed the first six years of its functional life. It was found that at 18 years of age M_2, with a functional age of 6 years, showed slightly less wear than M_1 at the same functional age, namely M_1 of a 12-year-old subject; in other words M_2 appeared to wear at a slightly slower rate than M_1.

This was an important stage to have reached because, especially during adolescence, there are several factors which could affect the rate of wear of the dentition; for example, the increase in the size of the dentition by the addition of molars posteriorly, the increasing muscular power of the jaws and the increased food intake associated with somatic growth. Furthermore, the position of the tooth in the arch might well affect the amount of work it does and hence the rate of wear; for instance, the rate of wear in the M_1 region is not necessarily the same as in the M_2 and M_3 regions. This study, however, suggests that these factors tend to neutralize one another and attrition seemed to proceed at a relatively constant rate. The rate of wear of M_1 did not appear to be slowed by the appearance of M_2 as a working unit in the mouth.

An observation made at this stage, which was utilized later, was that facets of wear appeared on the mesial aspects of the first and second molars, where they had contact with their neighbours, within a year or two of erupting and becoming functional.

As a next step in building up an age-determined series, skulls were selected which, from the small amount of wear of the third molars, could not be much older than those of the 'known age' group. These were put into serial age order on the basis of the amount of molar wear and their ages were then estimated by reference to the 'known age' group by careful comparison of the amount of M_2 and M_3 wear with M_1 and M_2 wear in the skulls of 'known age'; for example, a small facet of wear on the approximal surface of a third molar suggested that it had been erupted for not more than two years before death and led to a conclusion, providing other factors were consistent, that the skull was 20 years of age. If M_2 showed wear equal to eleven years of M_1 wear it was taken to indicate that the M_2 had also functioned for eleven years, or a little more, say one additional year, leading to an estimation for the age of the skull as 24 years. Finally, account was taken of the amount of wear shown by M_3 in comparison with the early degrees of wear of M_1 and M_2 in the series of 'known age'. In this way the data from the 'known age' group were projected forward for another six years to extend the period of what could be regarded as reasonably confident estimation up to the age of 24 years. This new group, added to the 32 skulls of 'known age' provided 38 skulls ranging from 6 years up to 24 years to provide a basis on which up to eighteen years of M_1 wear could be compared with up to twelve years of M_2 wear and up to six years of M_3 wear. These 38 skulls were regarded as the baseline group on which the ages of the other specimens could be assessed.

During the course of matching each molar tooth in years of functional age with others in the group the impression gradually became stronger that the second and third molars wear at a slower rate than the first molars. In fact, it is evident

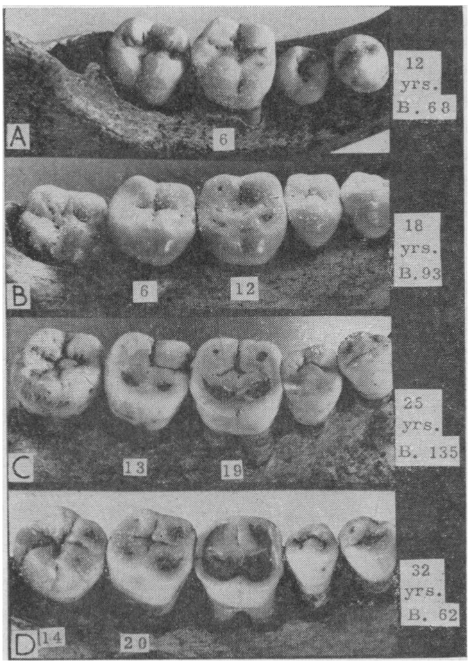

Fig 3 A, *mandible estimated, from state of partial eruption of* M_2 *and the premolars, to be from a person aged about 12 years. Hence functional age of* M_1 *is 6 years.* B, *mandible estimated, because* M_3 *is partially erupted, to be from a person aged about 18 years. Hence functional age of* M_1 *is 12 years.* M_2 *with a functional age of 6 years shows slightly less wear than* M_1 *in the specimen of* A. C, *mandible of which* M_2 *shows a degree of wear similar to that of* M_1 *in the 18-year specimen. The age is therefore estimated to be 25 years and it follows that the functional age of the* M_1 *is 19 years.* D, *mandible of which* M_3 *shows a degree of wear similar to that of* M_2 *of the 25-year specimen. The age is therefore estimated to be 32 years and it follows that the functional age of* M_2 *is 20 years and accords well with the close similarity between its state of wear and that of* M_1 *of the specimen of* C. *The serial numbers of the specimens and their estimated ages appear on the right. Figures overprinted on the specimens are the deduced functional ages of certain teeth*

that there is a gradient of rate in the molar region which diminishes slightly from before backwards. This gradient has been noted by other workers, particularly by Murphy (1959). It was decided that the steepness of the gradient could be reasonably expressed for the present purpose by the ratio of 6 : 6·5 : 7. This means that it takes only six years for M_1 to reach a state of wear that it takes M_2 and M_3 respectively six and a half and seven years to reach. It also means that if a third molar is found which matches a first molar which shows 18 years of functional age, by a simple calculation it is possible to say that the third molar is 21 years of functional age. It is necessary to emphasize that the ratio is merely an expression of a subjective assessment and to guard against the implication of mathematical precision that the use of figures tends to convey.

Making the assumption that the rates of wear of the molars remained constant throughout the life of the dentition, it was now possible to project the data still further to assess the age of the older groups. Once more skulls were selected which were functionally somewhat older than the preceding group and again, by comparing the M_3 wear with M_2 wear in the preceding groups and using the ratio 6 : 6·5 : 7 to calculate the functional age of

Specimen B.113

M_2wear = 31 years of M_1 wear

31 + 3 + 12 = 46

M_3wear = 28 years of M_1 wear

28 + 5 + 18 = 51 —— 49

M_3wear = 29 years of M_2 wear

29 + 2 + 18 = 49

Fig 4 *A typical example of the manner in which the age was estimated by calculating functional age from comparisons of molar wear*

M_3, age assessments for the skulls were arrived at. The wear of M_3 and M_2 was then compared with that of M_1 of the basic group. Similar calculations gave two additional age assessments for the skull. The mean of the three estimates was taken to be the presumptive age (Fig 3).

The ages given by the three separate calculations were usually not widely divergent as they would have been had the principle of the method or the ratio been completely wrong (Fig 4).

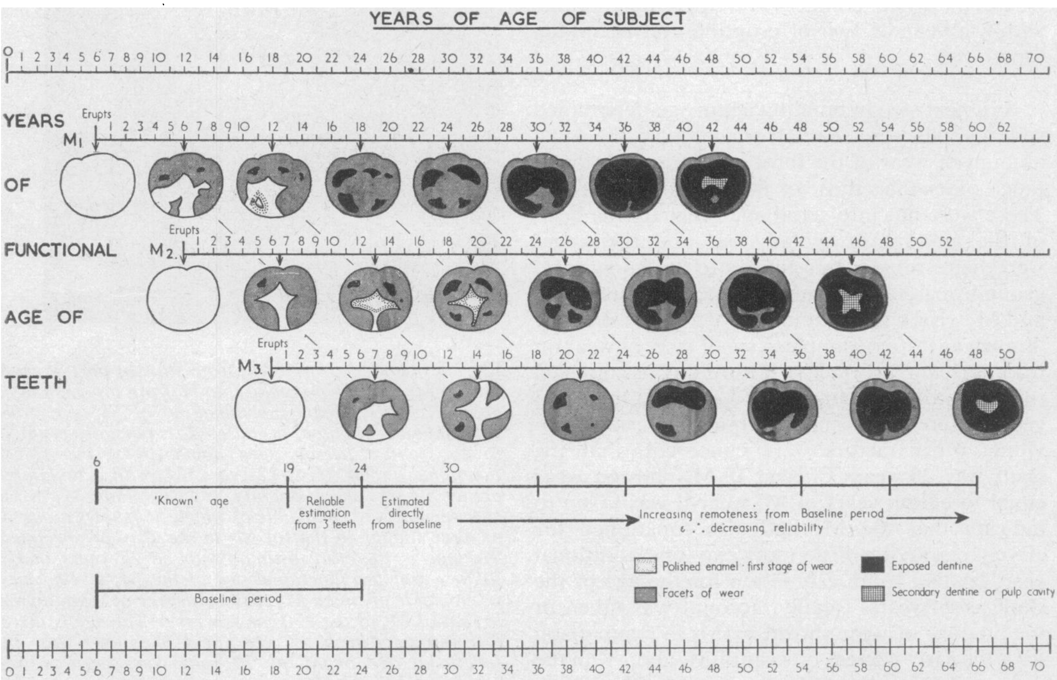

Fig 5 *Diagram showing the systematic use of molar wear for age assessment. The stages of wear of M_1 at six-year intervals are depicted against time scales of age of subject and functional age of tooth. The comparable stages of wear of M_2 and M_3, linked by diagonal broken lines, are indicated, but at 6·5 and 7-year intervals in accord with the 6 : 6·5 : 7 gradient of molar wear*

By taking successive groups of skulls and treating them in the same way the system was gradually extended by more and more periods which, because the initial intervals between eruption of the molars are six years, tended to amount each time to an advance of six years.

Fig 5 depicts the system diagrammatically. From this it can be seen that for skulls up to a presumptive age of about 30 years comparison was being made directly with the baseline group, whereas over that age the comparison was made with groups progressively more distant from the baseline group. The system is, therefore, one of decreasing reliability with advancing age.

It was possible, in this way, to include 73 of the skulls in age-determined series. By the presumptive age of 45–50 years, however, the dentition was becoming so worn that teeth were being lost either by exposure of the pulp, by abscesses resulting from food wedging between the teeth or by accidents and disease processes of various kinds. Where there was ante-mortem loss of teeth or abscesses or other lesions likely to be painful, a subjective allowance was made for the greater load of work that would fall on other parts of the dentition. Finally, there was a residue of skulls of a large variety of ages in which the dentition was too incomplete by ante-mortem or post-mortem loss for the wear of the teeth to be used systematically in the way described. The ages of these were estimated by simply matching the amount of wear of the dentition against the range of ones already estimated systematically.

The result was a collection of 157 skulls to which an age was assigned. The estimates are depicted in Fig 6 for comparison with the age-at-death distribution of a hypothetical present-day population of the same size prepared from the 1960 figures for England and Wales, for which I am indebted to Dr J A Heady of the M.R.C. Social Medicine Unit (The London Hospital). A much shorter expectation of life for the Anglo-Saxons is indicated by the peak of deaths at 35–40 years. In the Anglo-Saxon material there is no infant mortality peak, whereas infant mortality would certainly have been high. The absence of this peak in the Anglo-Saxon material is easily accounted for, however, by the failure of fragile infantile skeletal remains to survive prolonged burial. The peak of the Anglo-Saxon material at 15–20 years may represent a 'young warrior' class. Unfortunately, the sex characteristics of this group of skulls were too ill-defined to determine whether there is a preponderance of male skulls in the group. The mean of this Anglo-Saxon material was 31 years and, providing the assumption is made that the Breedon Anglo-Saxon population was a fairly stable one with a birth rate about equal to the death rate and with no marked immigration or emigration, gives a rough estimate of the expectation of life at birth for the population. It is interesting to compare this estimate of 31 years for an Anglo-Saxon population with estimates of 30 years for the expectation of life in ancient Greece and 35 years in thirteenth century England, quoted by Dublin *et al.* (1949). Fig 7, prepared from data quoted by these writers, depicts estimates for the expectation of life from birth for a number of historical periods. The figures for the earliest periods at least are based upon data which are probably no more reliable than those presented here for Anglo-Saxons; for instance, those for ancient Greece are based upon burial inscriptions. Such data, though providing accurate age records, might be supposed to be affected by age or status bias.

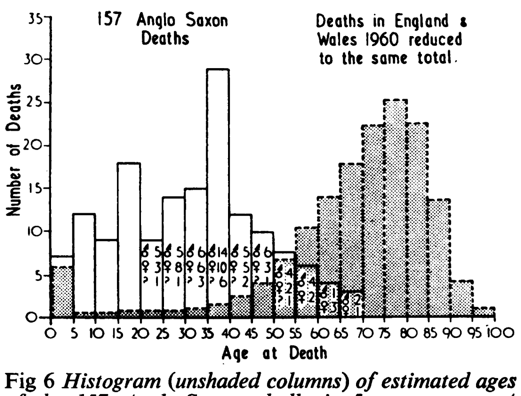

Fig 6 *Histogram (unshaded columns) of estimated ages of the 157 Anglo-Saxon skulls in 5-year groups. A histogram (shaded columns) representing the age distribution of 157 hypothetical deaths for a 1960 population is superimposed*

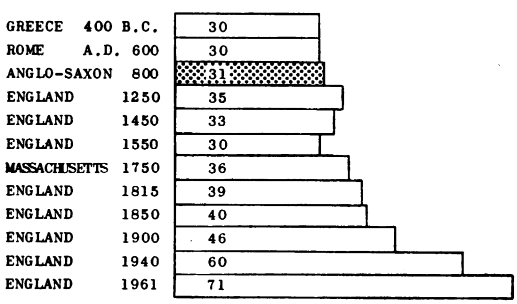

Fig 7 *Diagrammatic representation of the average length of life from ancient to recent times. Based upon Dublin* et al. *(1949)*

It must be evident that the Breedon data could not be applied directly to any other collections of skulls, except possibly those where it is reasonable to assume a closely similar way of life, especially in respect of food habits; for instance, it might be justifiable to use it cautiously to assess the ages of Anglo-Saxon material of similar antiquity. Nevertheless, the basic principle of the method and even the ratio should be applicable to any group of skulls provided it included sufficient dentally immature specimens to form a 'baseline group'. The application of the method would be very much aided if it could be shown that, although the actual rates of wear may differ in various populations according, principally, to the nature of the diet, the ratio between the rates of wear of first, second and third molars is more or less constant. Assuming that the ratio is constant, it would be necessary to establish the ratio more accurately than has been possible on the Breedon material. It might be possible to do this by making observations on living subjects if access could be obtained to people who not only experience a good deal of attrition but whose third molars, unlike those of most contemporary Europeans, do erupt and become fully functional.

Acknowledgment: Figs 1, 2, 5 and 6 are reproduced by courtesy of Pergamon Press and the editors of *Symposia of the Society for the Study of Human Biology*.

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The following short communication was read:

Cancrum Oris: A Preliminary Report

Mr R D Emslie (*London*)

A fuller report will be given in the Presidential Address to the British Society of Periodontology and will be published in the *Dental Practitioner*.