Review Article

AGE ESTIMATION OF HUMAN REMAINS USING THE DENTAL SYSTEM: A REVIEW

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ABSTRACT

Several methods of using teeth to estimate age at death are based on macroscopic, microscopic, and biochemical analyses of teeth. In addition to being very complex and expensive, microscopic and biochemical, methods destroy dental tissue and therefore make it impossible to use dental findings for further studies. The purpose of this article is to review the non-destructive methods of estimating the age of remains through teeth for immature people by examining the evolution of the dental system and for adults by examining the physiological analysis of dental tissues. Due to the regular nature of teeth formation and growth, "dental evolution" is the most widely used method to estimate the age of the remains of immature people. The traces of aging can be examined in the three different processes of the development of the dental system, "calcification", "teeth growth" and "complete closure of the end of the root" in pre-prepared tables and charts. Its wear begins with the eruption of permanent teeth. The prevalence of wear in a population is a function of age and can be used in age estimation. The continued formation of secondary dentin is also a biological response to aging. With age, the pulp area gradually decreases due to the continued deposition of secondary dentin. Measuring the trend of this decline using radiological photographs is used as an indicator in age estimation. The translucent end of teeth roots is also related to aging in adults and its length can be measured with proper accuracy. Although in archaeological samples, it still needs more investigation.

Key words: Age, Dental system, Human, Non-destructive methods.

Introduction

Normally, four indicators of sex, age, height, and race are investigated in bioarchaeology studies. Meanwhile, estimating the age of human remains is one of the most difficult issues in ancient biology, because people with the same chronological age show different biological ages. For this reason, osteologists and biological anthropologists use the term estimating the age of human remains in anthropological texts and reports. Age estimation itself is one of the sub-branches of forensic medicine, especially in cases of uncertain identity of the deceased [1-3], but today with the increasing interest in paleodemography such as the composition of age groups, sex ratio, and causes of death in societies, this The subject has become one of the most controversial and important topics in biological archeology [4, 5]. Age estimation can indicate the age difference in deaths from past societies. Reconstruction of their patterns provides researchers with an understanding of the living conditions that the people of these societies have faced in their historical ecosystems [6-8]. Along with age-related changes during the growth period, the development of maturity and aging occurs in the skeleton of each person. The appearance of age markers on the skeleton is different depending on the living conditions of each person [9, 10]. Most of the methods of determining the age of adults that are related to the changes made in the appearance of the body are based on the analysis of the visible (macroscopic) characteristics of different skeletal structures such as the symphysis pubis [11-13], the articular surface of the ilium bone [14], the sternal end of the ribs [15], and closing the external and internal seams of the skull [16, 17] are performed [18]. These methods divide age groups into broad ranges, often 5 or 10 years, and do not provide accurate results for people over 45 to 50 years of age. In addition, the skeletal structures used in these methods (pelvis and ribs) are usually subjected to post-mortem decomposition processes (taphonomy). Therefore, either they are not obtained in the exploration stages or they are so degraded that they cannot be used in osteological analyses [9, 19, 20]. Since skulls and teeth can provide a lot of information about age and time of death, several age estimation methods have been developed using skulls and teeth. In addition, in secondary burials, especially cases of reburial of the skull without other body parts, the methods of using the pelvis will be useless. In group burials in mass graves, it is often very difficult and error-prone to correctly assign different members to one person. Therefore, in these cases, by placing the skull as a criterion, the age estimation for each skull can be considered as the age estimation for each person regardless of the attribution of other bones to the individual.

The methods of estimating the age at the time of death are always expanding and improving, but it seems that the

methods based on changes in the dental system due to aging are more accurate than other methods based on bone findings. can estimate age; Therefore, teeth are much more useful than bones because of their high resistance to physical and chemical factors, when most of the bones have been destroyed due to various environmental factors, most of the teeth remain healthy [21, 22]. Several methods of using teeth to estimate age at death are based on macroscopic, microscopic, and biochemical analyses of teeth. Microscopic and biochemical methods, in addition to being very complicated and expensive, destroy dental tissue [23-26] and therefore make it impossible to use dental findings for further studies. The purpose of this article is to review the non-destructive methods of estimating the age of remains through teeth for immature people by examining the "evolution of the dental system" and for adults by examining the "physiological analysis of dental tissues". The question here is which of these methods can be used in human remains from archaeological sites? How are each of these methods used in age estimation and what are their advantages and disadvantages?

Chronological age and biological age

The point that should be mentioned at the beginning is the difference between chronological age (chronological age) and biological age (biological age). Calendar age is the number of days, months, and years that a person has passed since birth; but biological age, which is calculated based on biomarkers, is the changes that each person's body faces in the process of growth, development and aging. Biological age can be affected by internal factors such as heredity, hormone function, or underlying diseases and external factors such as nutrition, living environment, sports activities, work habits, etc., and therefore varies from person to person. It will be different. Mentioning an example can help us understand the difference between chronological age and biological age; suppose the average age of puberty for boys in a certain society is sixteen years, this means that the majority of boys in this society become adults at the age of sixteen. Therefore, the signs and symptoms of puberty appear in their bodies; obviously, some boys in this society reach puberty earlier and some later. Now, if we examine the skeleton of one of the boys of this community, in which the signs of puberty have appeared, according to the average age of puberty in the community, we can estimate his age to be sixteen years old, while this person may have been fourteen years old. In this way, although the chronological age of this person shows fourteen years, his biological age will be sixteen years. It is very important to pay attention to the fact that what we get in the examination of bone and dental findings will be the biological age of the person, not the chronological age. On this basis, wherever the word age or age at the time of death is used in this article, it means biological age.

Classification of age groups

Often, seven age groups are used in the classification of human bone remains: fetal (before birth), infant (zero to three years old), childhood (three to twelve years old), adolescent (twelve to twenty years old), adult young (twenty to thirty-five years old), middle-aged adults (thirty-five to fifty years old), and old adults (over fifty years old) [27].

Estimating the age of non-adults from teeth

The development of teeth is more related to chronological age than the development of other bone parts, and it seems to be strongly controlled by genetic (and not environmental) factors. Due to the regular nature of tooth formation and eruption, and because teeth are found in many archaeological contexts, dental evolution is the most widely used method for estimating the age of non-adult remains [28]. The traces of aging can be examined in three different processes of the development of the dental system: the accumulation of calcium in the tooth tissue (calcification), the teeth growing out of the jawbone, and the complete closure of the root end.

Estimating the age of adults from teeth

In this section, we examine three common methods in forensic medicine and archeology to estimate the age of adults from teeth. Other methods make it possible to estimate the age with more precision and accuracy, but since all of these methods are associated with the preparation of a cut from the tooth and the destruction of the dental tissue, they are omitted in this article.

Examination of dental wear

When a permanent tooth erupts and reaches the chewing surface, its wear begins. The amount and pattern of tooth wear are influenced by the following factors: the sequence of tooth development (early teeth are more susceptible to wear than later teeth), tooth shape and size, the internal structure of the crown, tooth angle, non-use usually from the teeth, the mechanism of the chewing system, and the individual's diet [29]. If the amount of wear in a population is almost the same, it can be concluded that the prevalence of wear in that population is a function of increasing age, and therefore it can be used to estimate the age of individuals. This method has also been tested in modern populations and the relationship between age and tooth wear has been well-proven [30, 31]. However, osteology should always be aware of cases of very severe wear that may occur due to pathology or the use of the tooth as a tool [32]. The first step in age estimation using the dental wear method is to use samples that show the growth and wear stages of teeth with age sequences. For the first time, Miles 1963 published a scale of wear based on the development process of teeth [33]. The basis of the method of using this scale is given in the following example: When a second permanent molar erupts in a person, the first molar has been exposed to wear for about six years (assuming the eruption of the first molar at the age of six). and the second molar at the age of twelve). Now, if the amount of wear with a pattern similar to this six-year wear on the third Asia (which is assumed to have grown at the age of 18) is seen in another person, the age of this person can be estimated as 24 years (6 + 18). Miles believes

that this method is not very accurate for estimating the age of people over 50 [34]. In 1985, Lovejoy, by examining bone samples from a prehistoric population and preparing a large collection with age sequence and tooth wear, concluded that tooth wear is an important and reliable measure in estimating age at death in people. It is mature and can give accurate results. Lovejoy and colleagues concluded that tooth wear is the single best measure of age at death in skeletal assemblages. They found that tooth wears as an age estimation scale has high accuracy and is consistent and without bias. Mies also found tooth wear as a reliable indicator for age estimation in a study of a very different historical Dutch population [35].

Age estimation and deposition of secondary dentin

Dentin tissue is the result of the continuous deposition of dentine cells. Secondary dentin is a tissue that is naturally and physiologically (and not pathologically) slowly formed by dentin-forming cells around the cavity of the dental pulp (pulp) in a linear fashion in very narrow tubes called dentinal tubules. The formation of secondary dentin begins after the completion of the root. There is a slight difference between primary and secondary dentin that can sometimes be seen under a microscope. The continued formation of secondary dentin appears to be a biological response to aging. Therefore, since with increasing age, the area of pulp tooth marrow gradually decreases due to the continuation of secondary dentin deposition, measuring the process of this reduction can be used as an indicator in age estimation [36]. The deposition of secondary dentin in teeth is studied in different ways, one of which is the use of X-rays and the preparation of radiographs [37]. Radiographic studies on teeth are done through two types orthopantomographic (OPG) and periapical (PA) radiography [36]. These studies are often based on three main methods: the Koval method [38, 39], the Ikeda method [39, 40], Kemmerer method [41, 42].

Measurement of sclerotic dentin

With time, the dentine tubules become narrower, which causes a semi-transparent appearance in the dentine. This process begins in the third decade of life and has nothing to do with dental health or gender. Studies have shown that the semi-translucency of the root end of the teeth, which is called translucency or sclerotic dentin, is related to aging in adults. In forensic medicine, the increase in the size of sclerotic dentin in the root end (apical) region of human teeth is used as a method to estimate age [43]. Measuring the length of translucency in millimeters can be done with proper accuracy. Bang and Ram in 1970 [44] devised a method by which the length of semi-transparent dentin at the end of the root was examined in two ways: cut teeth and complete teeth in human remains. Their formula has been tested on modern human remains (contemporary samples) of known age and archaeological remains of unknown age [45]. Currently, the most reliable way to measure dentine translucency is to measure it from a tooth section, but it is not recommended in archaeological samples. Because a cut tooth will be destroyed forever and cannot be used for other research; Therefore, the only way to study tooth translucency in archaeological samples is to use strong light and whole teeth without cutting [42]. Teng and his colleagues also investigated this method in estimating the age of archaeological remains from the 18th and 19th centuries with known age and using the method without cutting under strong light. They concluded that this age estimation method has comparable results with other age estimation methods of human remains used in this research. In this method, most of the estimates tend to be in the middle age category, that is, in young people, older age is estimated and in old people, younger age is estimated [45]. In 1999, Sengupta and his colleagues investigated the problems of age estimation with the translucency method in the roots of human teeth of different ages and found that the majority of archeological samples are associated with changes such as creating a chalky appearance on the tooth roots, which even remove This appearance of plaster on the root of the tooth will not affect improving the detection of the degree of translucency. Therefore, this method cannot be used in ancient samples [46]. However, it is possible to find examples in archaeological remains that do not have this problem, or that a way to remove the plaster layer formed on the root of the tooth can be found. It seems that the use of this method to estimate the age of dental remains in archaeological findings still needs more research.

Conclusion

Considering the great importance of estimating the age of human remains in paleodemographic studies and the increasing progress of new methods, it seems that dental anthropology is still a new foundation in this scientific category. New dental imaging methods (such as 3D imaging) along with new software will open wider horizons for researchers, which will undoubtedly have a significant impact on paleodemographic studies. According to what was said in this article, it is possible to estimate the age of human remains from the dental system in three age categories in separate ways. From birth to the age of 20: In people under the age of 20, the method of examining the development of the dental system is used. By using this method, it is possible to estimate the age of these human remains from birth to 20 years old, provided they have the third molar (wisdom). It should be noted that if you have a graph and check the complete closure of the ends of the roots, the estimate would be much more accurate. Twelve to forty-five years old: The next method of estimating the age of the remains is to use the examination of dental wear in different populations, which can estimate the age of the remains well from twelve to forty-five years old. However, this method is not recommended for people over the age of forty-five. When using this method, one should always pay attention to specific uses of teeth as tools, diseases, or habits that lead to excessive wear of one or more teeth. More than forty-five years old: Two methods are used in forensic medicine to estimate the age of human remains with older

people (old people). One of these methods is the Cameriere method obtaining the ratio of the area of the pulp to the total area of the tooth. One of the advantages of this method is that by having only one tooth (upper bite), the age can be estimated with high accuracy. However, on the other hand, if you do not have upper canines, this method will be ineffective. The need to prepare a radiograph of the tooth and the need for software and computer calculations make this method more expensive than other methods of estimating the age of the remains. Therefore, it is better to use this method only in cases where the age of the remains is more than forty-five years, and on the other hand, it is desired to estimate the exact age of the person. In the second method, using the Bang & Ramm method and calculating the length of the sclerotic and translucent dentin at the end of the root, the age of the remains can be estimated. One of the advantages of this method is the lack of equipment and high skill. However, it seems that the efficiency of this method in ancient remains still needs more investigations.

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