Age Detection Tool:Amino Acid Racemization???

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Abstract

One of the interesting applications of forensic odontology is age estimation by means of teeth. Age assessment proves to be a critical factor in the victim identification process. Teeth display a number of observable age related variables and they tend to remain intact under circumstances, which might alter or obliterate the rest of the skeleton. The procedures for age determination are complex. Different methods used to estimate age such as racemization are of interest among the rest as this method can be used in identification of living as well as dead.

Key Words: Forensic odontology, age estimation, amino acid racemization.

Introduction

The need for a reliable age detection method has never been more. In the past few years its importance is felt even more due to two main reasons: the first being the rise is number of unidentified corpses due to increase in the crime rate, and the second reason being the need to estimate the ages in cases where no valid proof of age is available.[1] Various methods that may help in defining age are: Radiological examination of skeletal and dental development [the most useful method using skeletal maturity are based on radiographs of specific structures such as epiphysis diaphysis of long bones medial extremities of the clavicle, epiphyseal head of the first rib fusion of sphenoid bone with basal part of the occipital bone where as in dental radiographs are visualized via OPG or cephalometric radiographs], radiocarbon dating, racemization etc.Among all the methods, racemization has captured most interest of Forensic Odontologists; as it can be used to estimate ages of both living as well as dead.[2]

Racemization by definition means conversion of an optically active substance into an optically inactive mixture of equal amounts of the dextorotatory (D) and levorotatory (L) forms. Amino acid racemi-zation (AAR) can be used to determine relative dates of biological materials such as bone, shell and teeth and has been used archaeologically for over 30 years as an age prediction tool.[3] Furthermore, Amino acid racemization (AAR) allows the possibility of being able to provide information on Paleotemperature (temperature during a past geological age) histories via cross-dated specimens.[1]

Racemization is a chemical reaction and a number of factors influence its rate. These include; amino acid structure, the sequence of amino acids in peptides, pH, buffering effects, metallic cations, the presenceof water and temperature. To establish a dating method the kinetics andmechanisms of the racemization reaction of free and peptidebound amino acids need to be established.[4]

Discussion

When identification of an unknown corpse is required, the chronological age to the individual at death is one of the most important objectives of Forensic examination. Race-misation has become an attractive option as it can be used for age estimation of living as well dead where the most common methods used for identification such as carbon dating fail.Various methods are utilized for determination of age from dentition. These may be described in four categories namely, clinical, radiographic, histological, physical and chemical analysis.[5]

**Flowchart 1 showing different methods of age estimation**
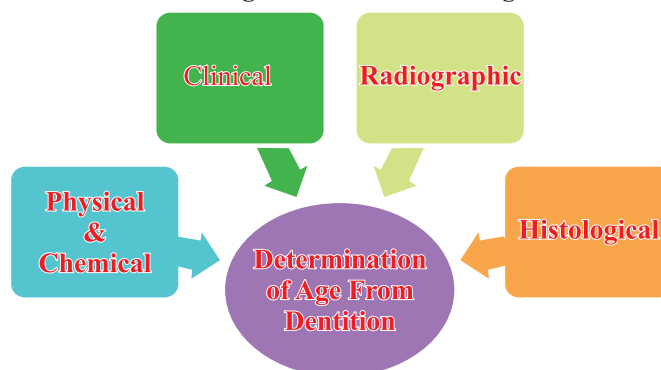
i) Clinical or visual method: Visual observation of the stage of eruption of the teeth and evidence of changes due to function such as attrition can give an approximateestimate of age.

ii) Radiographic method: Radiography can provide the grossstage of dental development of the dentition.

iii) Histological method: Histological methods require the preparation of the tissues for detailed microscopic examination, which can determine more accurately the stage of development of the dentition. This technique is more appropriate for post-mortem situations. It is also significant in estimation of age of early development of dentition.[6]

iv) Physical and chemical analysis: The physical and chemical analysis of dental hard tissues to determine alterations in ion levels with age have been proposed.[7] While these techniques, as yet, are not of great value to the forensic Odontologists, future developments might provide an adjunctive means of collecting evidence of value in the dental context.[6]

In Forensic Dentistry, racemization can help in identification and estimation of age when used in aspartic acid of dentin because racemization of aspartic acid in dentin protein during the human lifetime progresses with age.[7] The extent of racemization in of aspartic acid in coronal dentin of normal permanent teeth can be used in Forensic Odontology to estimate the age of an individual.[8]

Principle Of Racemization

Amino acids are the building blocks of protein and most can exist in two different forms levorotatory (L) and dextrorotatory (D), these forms are called enantiomers. In living organisms the amino acids in protein are almost exclusively Land the D/L ratio approaches zero. After death proteins break down and the D and L forms start to inter convert. This process is called racemization. In time the D/L ratio approaches one. If the D/L ratio is less than one it may be possible to use it to estimate age.[9]

Figure: I showing levorotatory and dextrorotary forms of amino-acids
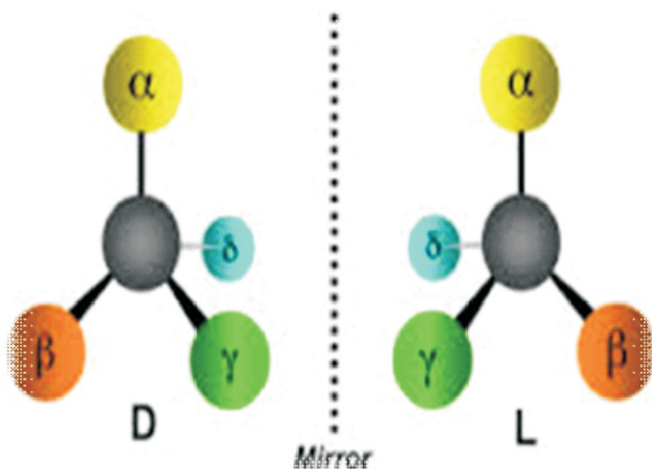
Amino Acid Racimization And Teeth

Amino acid racemization in teeth can also be hard to interpret.Racemization begins in a tooth immediately after it is fully formed and continues throughout the life of the host. Racemization continues after death but probably at a reduced rate due to the receding ambient temperature.[2]

Forensic medicine has brought age estimation into lime light since it narrows down the search and identification procedure Aspartic acid racemization in dentine is a well-established method for age estimation in forensic research.[5] Dentine has been the tissue of choice, as it forms early in the life of the individual and undergoes little biochemical turnover during life. Dental age estimation has thus gained preference over age estimation by bone because as compared to bone mineralization, tooth mineralization stages are much less hampered by environmental factors or by variation in nutritional and endocrinal status.[10]

AAR And Palaeotemperature Estimations

If the racemization rate for a particular system in any given material is knownthen AAR can be used to estimate the thermal history of any cross-dated samples.[1]

Conclusion

Advantages

• Based on the ratio of L and R amino-acids one can determine approximately how old a sample is.

• This technique is useful in both living and dead.

Disadvantages

• Amino acids are prone to oxidation and decomposition over time and probably are not the most reliable method for determining the age of samples. In addition, samples that are very old may yield very high errors due to the problem just mentioned. In this case, 14-C dating is preferred and recommended for much more accurate results

• Racemization is a chemical process and thus it is influenced by a number of factors such as: temperature, humidity, pH, etc so the results can vary within an error range of
+-3 year.11

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