

Age and sex determination

Application of combined aspartic acid racemization and radiocarbon analysis

Alkass K, Buchholz BA, Ohtani S, Yamamoto T, Druid H, Spalding KL

Mol Cell Proteomics 2010;9:1022-30

The determination of age and sex of the body can be crucial to the investigator to limit the search for individuals that could possibly match for missing persons. Traditional methods such as radiographic examination of dental and skeletal development to determine age are often imprecise, whereas more newer and sophisticated methods such as chemical analysis of tooth dentin by aspartic acid racemization and radiocarbon analysis give more accurate results. In this study, forty four teeth from forty one Swedish individuals were analyzed using aspartic acid racemization analysis of tooth crown dentin, and radiocarbon analysis of enamel.

Radiocarbon analysis showed an excellent precision with an overall absolute error of 1.0 ± 0.6 years. Aspartic acid racemization also showed a good precision with an overall absolute error of 5.4 ± 4.2 years. Radiocarbon analysis gives an estimated year of birth whereas aspartic acid racemization analysis indicates the chronological age of an individual at the time of death. The combination of these methodologies can help the forensic people to determine the identity and time of death of unidentified individuals.

Determination of sex from tooth pulp tissue

Veeraraghavan G, Lingappa A, Shankara SP, Mamatha GP, Sebastian BT, Mujib A

Libyan J Med 2010;5:10

Sex determination can be done with morphological analysis of the tooth, and deoxyribonucleic acid (DNA) analysis of the pulp tissue. This study was carried out to determine the sex from tooth the pulp tissue, by staining with quinacrine hydrochloride dye. Sex was determined by identification of Y chromosome fluorescence in the dental pulp tissues.

Sixty maxillary and mandibular premolars were collected and categorized into three groups: group 1, pulp tissue examined immediately after extraction; group 2, pulp tissue examined one month after extraction; group 3, pulp tissue examined five months after extraction.

Results showed no variation between the groups. A decrease in Y positive cells' in the elder age group of male sex has been noted which reduces the reliability of the study. The method employed in the present study proved to be a reliable and cost-effective technique for sex determination in the immediate postmortem period up to one month after death.

Automated biometrics-based personal identification of the Hunter-Schreger bands of dental enamel

Ramenzoni LL, Line SRP

Proc Biol Sci 2006;273(1590):1155-8

Human identification is becoming more and more important, and the term 'biometrics' is used to refer to identification techniques which are based on physical characteristics of a person. Dental enamel is characterized by layers of prisms of regularly alternating directions, known as Hunter-Schreger bands (HSB). The pattern variations of these bands are referred to as toothprints, and they resemble the minutiae in fingerprints. Minutiae are points present at the ending lines and at the bifurcations when one line splits into two. They are the major parameters used for algorithm extraction in softwares' used as automated identification systems.

In this study, they used fingerprint identification software to evaluate the HSB singularity in human teeth. The sample comprised of 262 central incisors. After contrast enhancement, the images of HSB were extracted by using the software, VERIFINGER DEMO. 2SDK/FINGERSEC and formulated. Based on results, it was proved that toothprint is a non-invasive, accurate and suitable physiologic biometric trait for human personal identification and verification.

Year of birth determination using radiocarbon dating of dental enamel

Buchholz BA, Spalding KL

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Radiocarbon dating is typically an archeological tool rather than forensic one. For radiocarbon analysis of tooth age,

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the upper limit of the enamel formation is used, that is the time of enamel lay down completion which balances lag periods of ¹⁴C incorporation from the atmosphere to the body. In this study, enamel isolated from human teeth is processed to form graphite and carbon14 (¹⁴C) levels are measured using accelerator mass spectrometry, since there is no turnover of the enamel after it is formed. ¹⁴C level in the enamel represents ¹⁴C levels in the atmosphere at the time of its formation.

The technique reports accurate determination of age with precision ± 1.5 years. Birth information significantly helps investigators in identifying deceased individual. In such cases, police will try to match particulars of the unidentified individuals with particulars from missing person list.

Age estimation for dental patients using orthopantomographs

Karaarslan B, Karaarslan ES, Ozevik AS, Ertas E
Eur J Dent 2010;4:389-94

Various methods were used in determination of age. In this study, age is determined by using orthopantomographs (OPGs). The OPGs of 238 turkish individuals of known age ranging from 1-60 years were studied. OPGs were selected according to the following criterias: both mandibular branches had to be of equal width; the curve of spee had to appear concave; and, the depth of field should be given. The evaluation criteria for the OPGs included: presence of primary teeth; presence of mixed dentition and third molar teeth; apexogenesis and maturation stage of third molar teeth; enamel attrition; level of teeth; width of the rootcanal and pulp cavity; and, level of alveolar bone resorption.

OPGs were evaluated by two independent dentists, and age estimation was achieved according to the decades.

Among 238 OPGs, the first dentist predicted 174 of the cases (73.1%) correctly and 64 of cases (26.9%) incorrectly. The second dentist predicted 171 cases (71.8%) correctly and 67 cases (28.2%) incorrectly.

Age estimation is of wider importance in forensic medicine, not only for the purpose of identifying deceased victims, but also in connection with crimes and accidents. The method used in this study can be applied to living persons as well. The age estimation through evaluating OPGs was most accurate in the first decade and least accurate in the fourth decade. Thus, OPGs cannot be regarded as a precise method of age estimation.

A new method for sex determination based on detection of sex determining region Y, steroid sulfatase and amelogenin gene regions with simultaneous amplification of their homolo-

gous sequences by a multiplex polymerase chain reaction

Morikawa T, Yamamoto Y, Miyaishi S
Acta Med Okayama 2011;65:113-22

In this study, a new method for sex determination by using a multiplex polymerase chain reaction (PCR) was employed. Sex determination from specimens gathered from crime scenes plays an important role in investigations. The molecular biological method for sex determination is based on polymerase chain reaction and has been applied to the forensic cases in which a single plex PCR for a sequence in the sex determining region Y (SRY) gene on the Y chromosome (Yp) is used. These methods can indicate a male genotype by the presence of amplified product from SRY gene; however, cannot accurately indicate a female genotype.

The major advantage of this study is its ability to detect both upstream and downstream sequence of the SRY gene simultaneously, which assures a consistency between the test results and genotypic sex.

Another advantage is that the presence of X and 7th chromosome specific fragments acts as an internal positive control which by itself can assure successful amplification, and positively indicate a female sample. During the examination of 246 blood samples by this method, no contradictions between the results and the known sex of the donor were observed. When the amelogenin Y (AMELY) - deleted male samples were analyzed, only an X chromosome specific fragment was amplified from the amelogenin locus, and based on this locus solely, the sample would have been considered as a female. However considering the results obtained from the additional markers i.e. SRY-a, SRY-b, STS-1 the sample was determined to be male. Thus, this method is applicable even to the specimen from AMELY-deleted male. In forensic cases, sex determination from the degraded deoxyribonucleic acid (DNA) samples is required.

In this study, using heated blood stains as a model of DNA degradation, the sex was correctly determined from the sample heated at 150 degree celsius for ten hours. These findings also indicated that the method would be satisfactory for practical application. In 35 forensic cases, the sex was determined successfully from all of the specimens of blood, muscle, organ, cartilage, tooth and bone in which DNA degradation had occurred due to environmental insult. This study has proved to be an accurate, reliable and a robust technique of determining the sex of various forensic biologic samples.

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