RESEARCH ARTICLE

AGE ESTIMATION BY FORENSIC ODONTOLOGY

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ABSTRACT

Cancer Age estimation by assessment of dentition is an unique application in forensic odontology. This is important in those cases, where the rest of the skeletal remains are obliterated, but tooth remains intact under all the adverse circumstances. Since the process is complex, various methods have been formulated to evaluate the dental age of an individual.

Key words: Radiographs, Dental pulp, Incremental Lines, Coronal Pulp

Citation: Dr. Youginder Singla, Dr. Rajni Sharma, Dr. Alok Mishra and Ramni Sharma. 2018. "Age estimation by forensic Odontology" *International Journal of Current Research in Life Sciences*, 7, (05), 2097-2100.

INTRODUCTION

Age estimation has applications both in post-mortem identification as well as living individuals in whom the chronological age is under dispute. It finds its use in:

- Identifying unknown human remains through dental records and assisting at the scene of mass disaster.
- Eliciting the ethnicity and assisting in building up a picture of lifestyle and diet of skeletal remains at archaeological sites
- Age estimation of both the living and deceased
- Presenting evidence in court as expert advice
- Determining the sex of an individual
- Analysis and identification of bite marks found on victims of attack and in other substances such as food stuffs

This article will review different methods of age estimation by forensics.

Dental age Estimation Methods

Dental age estimation makes use of morphological, radiographic, histological and biochemical methods to determine age dependent changes in teeth.

Age estimation using the dentition is categorized into 3 phases:

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- Pre-natal, neonatal and early post-natal period
- Children and adolescents
- Adults

Morphological/Clinical/Visual Method

- Most reliable
- Easy approach
- Clinical observation of the stages of eruption and the degenerative changes in the dentition, such as attrition, abrasion, etc[1].

Radiographic Method

- Simple
- Non invasive
- Age estimation of living and unknown dead
- Gives information about appearance of tooth germs, stages of mineralization, degree of crown completion and eruption of crown into oral cavity[2].

Histological Method

- Require the preparation of the tissues for detailed microscopic examination
- Determines the stage of development more accurately[3].

Physical & Chemical Method

- Determine alterations in ion levels[4]
- Future development might provide an adjunctive means of collecting evidence of value in dental concern[5]

Various Factors for the Age Estimation by Dentition[6]

- Earliest detectable trace of mineralisation
- Rate of formation of enamel and formation of neonatal line
- Appearance of tooth germs
- Degree of completion of unerupted tooth
- Clinical eruption
- Degree of completion of roots of erupted teeth
- Degree of resorption of deciduous teeth
- Attrition of crown
- Formation of physiologic secondary dentin
- Formation of cementum
- Transparency of root dentin
- Gingival recession
- Root surface resorption
- Discoloration and staining of teeth

Age Estimation in Prenatal, Neonatal and Early Postnatal period

The primary tooth germ begins to form at 7 weeks IU and the enamel formation of all primary teeth is usually complete by the 1st year. Permanent 1st molar shows germ formation at about 3-4 months IU. It makes use of histological techniques which enable observation of tooth mineralisation up to 12 weeks before it is seen on radiographs, hence very accurate. The "Neonatal line" is considered as an indicator of birth.

BOWERS: Attributes its formation to the showing down of enamel prism growth rate, thus "creating an apparent line of demaracation".

CIAPPARELLI : Neonatal line takes up to 3 weeks after birth to form. If the neonatal line is present, it indicates a live birth. Estimating age in this phase may have legal implications in case of feticide and infanticide.

Age Estimation in Children and Adolescents

Tooth emergence and tooth calcification are used to determine age in children and adolescents.

NYSTROM and colleagues consider tooth emergence to be a convenient clinical method of age estimation. It involves visual assessment of teeth present in the mouth and requires little expertise & equipment. This should be restricted to primary teeth because their emergence is under genetic control and relatively regular, commencing approximately at 6 months after birth & completing by 2.5 years. In contrast permanent teeth are under influence of the intra-oral environment and affected by infection, arch space and premature tooth loss.

Evaluating radiographs to assess calcification of permanent dentition is better option for age estimation because:

- Calcification of teeth can be assessed on radiographs for a period of several years
- Not altered by local factors such as lack of space, over retention of primary teeth, etc.
- Access age at periods when no emergence takes place (2.5 – 6 years &>12 years)

SCHMELING &associates: consider dental calcification as most suitable methods of estimating age in criminal procedures.

- Simple and easy to master
- Relatively accurate
- Better indicator in first 2 decades of life

SCHOUR & MASSLER's METHOD

- Based on histological sections and permit direct comparisons with radiographs.

The Schour & Massler's pictorial representation of teeth development
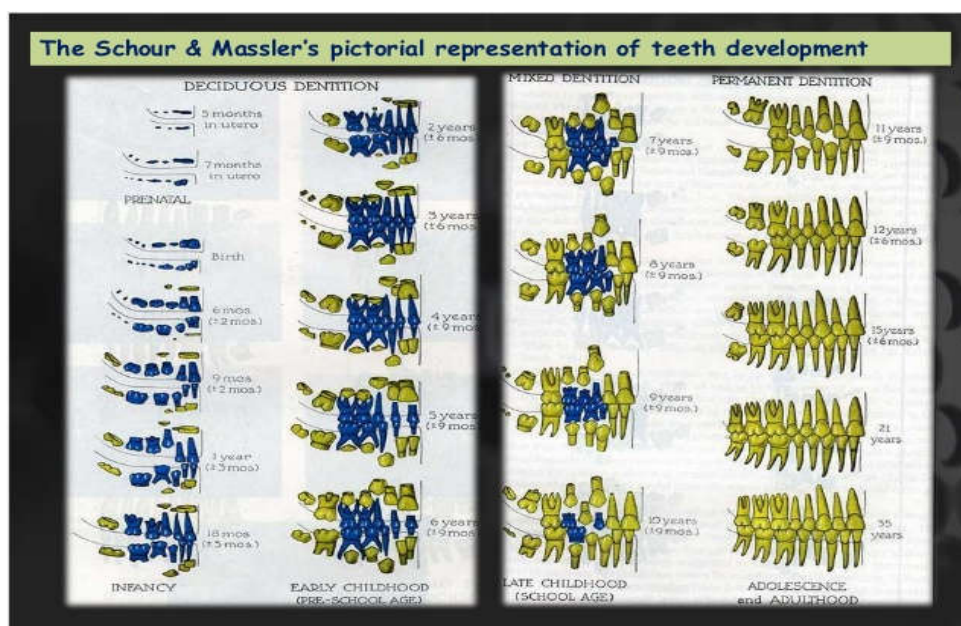
STACK: an alternative to measure dry weight of the mineralised tooth cusps. The developing teeth in a child at 6 months IU weigh about 60 mg, 0.5 mg in a new born and 1.8 gm at 6 months after birth.

Demirjian's Method

- Assesses the mandibular left side teeth
- Most widely used method in children and adolescents due to detailed description & radiographic illustrations of tooth developmental stages

- Relative simplicity

DEMIRJIAN'S METHOD

- The development of seven mandibular teeth on the left side was divided into eight stages each.
- These stages were named 'A' to 'H',

A		A – Mineralized cusp tips, not yet coalesced
B		B - Mineralized cusps united
C		C - The crown is approximately half formed
D		D - Crown formation is complete to the dento-enamel junction
E		E – Root formation has begun
F		F - Root length at least as great as crown length
G		G – Parallel root walls with open apices
H		H – Apices are completely closed

VALUE OF 3RD MOLARS IN AGE ESTIMATION

Although 3rd molar is a valuable indicator of age in 23 years old group where all other teeth have completely developed, its accuracy in age estimation is questionable due to great variation in its genesis, position, morphology and time of formation.

Age Estimation in Adults

RITZ & colleagues state that following completion of growth, changes in the dentition used to estimate age "are influenced not only by the age of the individual, but also by numerous endogenous and exogenous factors, such as disease, nutrition and physical strain".

GUSTAFSON's METHOD

GOSTA GUSTAFSON in 1950 proposed a method for age estimation based on morphologoical and histological changes of the teeth. This assessed regressive changes such as:

- Attrition (A)
- Secondary dentin deposition (S)
- Loss of periodontal attachment (P)
- Cementum deposition at the root apex (C)
- Rootresorption at the root apex (R)
- Dentin translucency (T)

- Assigned different grades ranging from 0-3
- Formula: 11.43+4.56X (where X is the total score)
- The error was ± 3.6 years

DALITZ METHOD (1962)

- To overcome the errors of Gustafson's method, Dalitz came up with a 5-point system to score the regressive changes.
- The results suggested that the factors such as attrition, secondary dentin deposition, periodontitis and transparency of the root of the 12 anterior teeth are related to age
- Root resorption and secondary cementum were discarded to achieve greater accuracy in age estimation[7].

- Formula: E = 8.691 + 5.14 A + 5.338P + 1.866S + 8.411T
- Drawback: it did not take bicuspids and molars into account.

Bang & RAMM Method (1970)

- Transparency was first evident at the root apex and moves towards the crown of the tooth
- Thus it is used throughout the adult life in the period in which dental eruption cannot provide reliable age estimation and very important when the sex of the individual cannot be determined.

Kagerer & GRUPE Method

- Possibility of age estimation from acellularcementum incremental lines
- Use of mineralized, unstained cross-sections of teeth
- Accuracy to within 2-3 years of actual age
- Hypomineralized bands in the incremental lines give an indication of events such as pregnancy, skeletal trauma and renal disorders
- Necessitate tooth extraction, sectioning and destruction
- This is possible in dead individuals, but not practical in living adults

BIOCHEMICAL METHOD

Amino Acid Racemization

*HELFMAN and BADA:*suggested a relationship between age and the extent of aspartic acid racemization in dentin

RITZ and associates & OHTANI and co workers: ratio of D – aspartic and L – aspartic acid is used for age estimation. This can be measured in those proteins that are synthesized early in life and are not replaced. Such proteins are found in brain cells, crystalline lens, bone and teeth. Racemization rate is high in dentin; therefore teeth are valuable source of age estimation.

- *WAITE and colleagues*:believe that this is an objective method that is very accurate, with age estimation within ± 3 years of actual age.

Age estimation from C^{9}levels

- Scientist in Sweden and the US have recently proposed a highly unconventional and path breaking concept of age assessment developed by SPALDING and associates, measure the amount of Carbon – 14 isotope in enamel and compares it to recent atmospheric levels of C – 14.
- Disadvantage: expensive equipment

RADIOGRAPHIC METHOD

- KVAAL and associates developed a method that used maxillary central, lateral incisors and 2nd premolar; mandibular lateral incisor, canine and 1st premolars
- The measurements included several length and width ratio such as pulp-root length (P), pulp-tooth length (R), tooth-root length (T), pulp-root width at CEJ (A), pulp-

root width at mid root level (C) and pulp-root width at mid- point between level C and A (B)

- Ratio is used to compensate for magnification and angulation errors
- Formula : Age = 129.8 – (316.4 × M) – (66.8 × (W-L)

Conclusion

Age estimation by forensics poses a complex problem and need considerable experience in assessing significant changes and allowing for their variability within the population. Dental age estimation by forensics can bring a high tide wave if done accurately, when other options seem desolate.

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