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Role of Dental tissue in Anthropological Research.

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ABSTRACT

For several years, anthropology focused only on the biological understanding, diet, environment, form and function of various human skeletal remains. The use dentition for identification has been well established in the field of forensics. Anthropological research has now extended its approach into examination of dental tissues in medico-legal cases. Among all the skeletal remains, teeth stands in the heart of evolutionary studies which remains preserved in the most intact state even after the depart of an individual's sole from this world. Several studies have now been focused on the internal structure, chemical composition (incremental pattern of growth) and morphology variation of teeth. Humans are thus known to exhibit these characteristic regional and temporal patterns of tooth size and shape. This review briefly describes an over view of the importance of dental tissues in anthropological research and their application in forensic medicine.

Keywords: Anthropology, forensic dentistry, dental anthropology, tooth morphology

Introduction

Dental anthropology can be defined as the study of morphological traits and pathologies associated with teeth in skeletal tissues of dead remains.[1] Recently, this branch has taken its area of major concern as it is dealt by a combined effort of anthropologists and forensic odontologist. Research has taken us in through various morphological traits (dimensions & shape) of teeth along with pathological aspects involving enamel, dentin and cementum of teeth.

'Corpus Hippocratum' (5^{th} century BC) was the first to shed light on dental anatomy, growth and various clinical dental disorders. Since then, scientists *(anthropologist and odontologist)*brought to public notice regarding several morphological variations of teeth. Finally, a milestone in this field was set by the birth of Dental Anthropology association (1983) with several scientific publications following it.

Age and sex determination thus remains absolutely necessary for positive identification of an individual and share adequate data for demographical analysis in anthropological research.

Importance of teeth

Dental anthropology utilizes teeth as a source of evidence from human population for resolving several anthropological problems.[2] Teeth can be used ideally as evidence since its presence depicts various clues in the court of law. Teeth can be best studied due to three characteristics – Preservability, Variability and Observability. They include[3]

- Strong hereditary component of population relationship – evolutionary dynamics
- Tooth patterns – Dietary background
- Modifications of teeth – cultural characteristics
- Developmental defects – environmental stress among population

Dental traits

Human dentition is broadly classified into Biphyodont - primary/deciduous teeth (incisors I^2, canines C^1 and molars M^2) and permanent teeth (incisor I^2, canines C^1, premolars PM^2 and molars M^3). Incisors and canines form anterior teeth and premolars and molars form posterior teeth. The tooth is divided anatomically into crown and root portion. In brief, the crown as covered superficially by enamel with underlying dentin (96% & 70% mineralized) respectively. The root portion of the tooth is anatomically covered by cementum (45-50% mineralized) overlying dentin.[3]

In human oral cavity, these teeth have been strongly held to the upper (maxillary) bone and lower (mandibular) bone by soft tissue fibers. We have started giving prime importance to these dental tissues due to its unique genetic make-up, inter & intra-variations of teeth among the primates. Also, these structures along with alveolar bones show its presence in original form in cases of mass disasters. In contrast to the basic anthropological research, dental sciences have evolved its role to exhibit normal and pathologies of teeth, and restorations of these decayed teeth in rehabilitating and providing functional form of teeth.

Discussion

Morphological variations of human dentition

Normally, internal and external morphological form of human teeth with root morphology show a. Incisors – square shaped crown with tapered conical root, b. Canines – Pyramidal crown with long conical root, c. Premolars – Bicuspids with one root (Maxillary 1^{st} premolar – 2 roots), and Molars – Five cusped tooth with two roots (mandibular) and three roots (maxillary).[1]This collaboration between an anthropologist to forensic odontologist is needed to bring the characteristics deviated from the above normal. Variations of teeth include crown shape changes like showel shaped incisors, peg laterals, labial incisor groove, accessory cusp on incisors, premolars and molars (talon

cusp, dens evaginatusprotostylidand cusp of carabelli) and grooves (Y, + and X-grooves).Root morphology are defined in number of roots (one, two or three roots) and root shape (dilacerations). All these morphometric variation are noted using a digital caliper or verniercaliper for measuring mesio-distal and bucco-lingual dimensions of teeth.

Morphological teeth variation also included interproximal grooving, alternate intercuspation (deviated occlusion of teeth) and helicoidal plane of occlusal curvature running through the occlusal aspect of teeth. Malocclusion of teeth (Angle class I , II and III) adds to uniqueness of each individual dental status.[4]

Beyond the normal calculation of mesio-distal and bucco-lingual diameters of crown in sexing teeth, advanced techniques like computer assisted programming have been used to estimate cusp base areas in posterior teeth. Decreased mean cusp size and cuspal variation was observed in the following sequence - protocone>paracone>metacone>hypocone. Greater differences in variation of distal cusps of molars correlated with sexual dimorphism.[5]

Histological variations in teeth

Anthropologist have been interested for long in the accurate diagnosis using unique technique of histological analysis of teeth. Several methods like physical sectioning, radiography, computed tomography (CT) and Virtual dental tissue imaging[6]aid in determining the thickness of enamel and dentin in human teeth.[7] In specific, tooth sectioning and preparation of histological specimen aid in linear increments when viewed by light microscopy.

Previous studies of evolutionary developmental biology in humans showed that mineralized tissues are deposited in a layered/repeated rhythmic pattern (incremental pattern) of deposition prior to birth, extending till adolescence and remains unchanged several yearsin fossil teeth. Thus, these incremental lines remain unchanged from birth through periods of stress till death depicts the regular and rhythmic deposition of mineralized tissues of teeth.. Certain developmental factors like differences in brain size, body mass, metabolic rate, diet and life history relate to the variations of this histologic picture unique in each individual.[8,9]

1. Enamel - Incremental lines of retzius (long period) & Cross striations (short period)
2. Dentin - Von Ebner lines, Contour lines of Owen and Andersen lines
3. Cementum - Incremental lines of salter [10]

Other features include rate of tooth eruption, enamel & dentin development time, crown formation time, hypoplasia, periodicity and Perikymata on teeth structures.

Dental Tissue Pathologies

Pathology is referred to any anomaly that deviates from normal. As tooth is in constant contact to the external environment, they are susceptible to various external influences. Several pathologies of teeth that are of prime concern to us in anthropological research include dental caries, enamel hypoplasia, teeth wear, tooth staining and tooth fillings.

-Dental caries – Decay of teeth is a slow progressive destruction of inorganic substance (mineralized component) followed by dissolution of organic substance of teeth.[11]This process gradually occurs as a result of biochemical reaction between teeth, microbial action and fermentation of starch. The location of this disease process as a blackish discoloration to cavitation

on occlusal, mesial, distal and incisal portions of teeth providing a chief clue to the anthropologist on dead remains.

- *Enamel hypoplasia* – This developmental anomaly commonly occurs in children among 6-7 years. The presence of several transverse lines on a single tooth or several teeth as a result of nutritional insufficiency and underlying periapical disease results in hypoplastic tooth.

-Teeth wear: Tooth wear can occur as a physiological process (attrition) or pathological process (erosion, abrasion and abfaction). In observing the marked occlusal and proximal wear facets on several teeth, one can conclude the age and working environment of an individual. Variations in degree and extent of tooth wear between populations are concerned with the lifestyle and abrasiveness of teeth. It has also been documented that adaptive changes of the stomatognathic system in response to tooth wear indicated dynamic craniofacial complex.[12,13,14]

- ***Attrition*** - 'Tooth-to-Tooth wear' occurs as facets associated with teeth of the opposing arch. Presence of well defined shiny facets forms a good measure of attrition. [15]
- ***Abrasion*** - This predominant mechanism is associated with 'scooped' out wear facets of posterior teeth in association with mechanism of hard abrasive material. This wear facets determines the age and individual habitat concerned with crime cases.
- ***Erosion***- This pathological condition is characterized by the presence of deep concavity on the surfaces of teeth in contact with acidic beverages. This again forms a source of identification mark on teeth in medico-legal cases.

Anthropologist in earlier population extended their efforts for defining the association between tooth wear – culture, gender, age, craniofacial geometry, tooth size, dental traits and diet. Later, the same tooth wear mechanisms was correlated with abrasiveness of food, cultural practice, genetic and environmental variations in humans. Research on dental pathologies stated that the presence of dental caries, periapical lesions with cyst or abscess formation leading to resorbed tooth roots and supporting alveolar bone. Presence of these lesions indicated the multiple factors in biocultural environment relating to a. dietary pattern, b. exposure to new diseases, c. professional conflict and e. increased population density.

1. ***Teeth staining-*** Teeth could appear discolored either as a developmental defect or due to extrinsic environmental factors. Common developmental defects include tetracycline staining (yellow teeth) or porphyria staining (red teeth). Environmental factors like smoking or drugs taken after birth may result in bluish-black discoloration of teeth.
2. ***Tooth fillings (restoration)*** – During the lifetime, human population is more prone to common diseases like dental caries. As a result, several teeth appear filled with variety of restorations (amalgam or tooth colored transparent cements). These intact restorations or broken filling may remain preserved in human dead remains.

Advances in Dental Anthropology

Teeth is highly mineralized structure that appears to be the only preserved structure in comparison to other skeletal remains that often appear distorted.[16]

Sexual dimorphism

External tooth dimensions play a major role in determination of the sex of the skeletal remains. Mesiodistal (MD), buccolingual (BL) dimensions and height of the crown play a major role in discrimination of sexual dimorphism. Predominantly, crown size with increased dentin thickness is observed in canines of males as compared to females.

Age estimation

Teeth in particular could be used in analysis of age of an individual as they exhibit a definite developmental sequence – crown and root formation, calcification time and eruption. Correlation between dental age and chronological age estimation seems superior over the skeletal age estimation. Dental age is determined by estimating calcification stages of teeth while chronological age is estimated by reading the eruption status of teeth and ossification of maxillary and mandibular alveolar patterns.

Age of dental remains recently has been estimated using various histological methods in examination of cementum annulations rings and secondary dentin deposits. Morphological methods of sex determination using teeth include dental attrition and root translucency. Furthermore, structural variation in teeth with age could be determined by estimation of mineral thickness with advancing age using non-destructive ultrasound imaging pulse-echo technique. [16]

Accentuated incremental lines in enamel (neonatal lines) provide a role of forensic relevance in children. In dentin, Andersen lines, contour lines of owen and sclerotic dentin correlates with the age at death using dental remains.[3] Surface of cementum (peri radicular bands) along with its rate of estimation determines the dental age in anthropological survey.

Conclusion

Dental analysis has been used for the positive personal identification in cases of mass disasters. In the present Indian scenario, a collaborative work between anthropologist in forensic field with odontologists aid in the examination of dental hard tissues (morphological and histological variations) in assessment of sex and age of the individual.

Conflict of interest

The authors hereby declare no conflict of interest.

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