Teeth, genes, and genealogy

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The dental profession's reliance on teeth as the sole reason for its existence needs to be tempered by the realization that many other avocations are dependent upon dentitions. A number of related disciplines rely upon teeth as the elements of evidence of their sciences. Thus, the disciplines of genetics, odontology, paleontology, human evolution, diets, forensics, and diseases should come under the wider aegis of the dental profession and within the compass of dental relevance and pertinence.

The genetic determination of teeth make teeth the epitome of gene expression patterns, for every cusp, fissure, and pit is genetically determined. Any variation in the genetic code produces variation in the morphology and diseases of the dentition, wherein dentists must take cognition.[1]

Every stage of the development of the dentition is determined by a genetic signaling network that provides the molecular milieu of odontogenesis. Thus, the familiar stages of initiation, cap formation, bell stage, enamel and dentin mineralization, culminating in eruption are subject to extremely complex but highly regulated genetic patterns.[2] No less than 14,802 genes are expressed in dentinogenesis, while amelogenesis invokes 15,179 genes in presecretion mineralization and 14,526 genes in enamel secretion.[3] These multiple genes are replicated in microarray probes at different stages of development. The detailed identification of these dental genetic transcriptomes (the "dentome") reveals the diverse molecular pathways incurred in odontogenesis that will lead to the etiology of defects of dental development and ultimately their possible prevention.

The burgeoning field of paleoanthropology is largely dependent upon the evidence provided by teeth. Detailed dental morphology peculiar to different species provides the necessary information to define the distinguishing features of evolutionary branches of anthropology. The size, shape, and cusp and fissure patterns of teeth are among criteria upon which some species are denominated.[4] The retention of DNA in the dental pulp of long-deceased individuals provides the evidence by paleogenomics of the genealogy of the recovered remains that serve not only in anthropology but also in forensic odontology. Developments in paleontology, zoology, and paleoanthropology are dependent upon the evidence provided by teeth. Dental data play a central role in revealing the pathways of hominin evolution.[5]

The recent revelations of a newly described specimen of hominin evolution are largely dependent upon the dentognathic evidence revealed in the 3- to 3.5-million-year-old jaws of *Australopithecus deyiremeda* (Fig 1).[6] The massive mandible is indicative of powerful masticatory requirements, abetted by the exacerbated thickness of the molar enamel, comparable to that in other australopithecine specimens. These features reveal the demands of a tough diet of sedges and twigs upon which these creatures are presumed to have subsisted. A curiosity of the anterosuperior direction of opening of the mental foramen evident in the mandible contrasts with the postero-inferior opening of this foramen in contemporary humans. This directional contraposition reveals a mandibular growth contrast between australopiths and humans, accentuated by a lack of a projecting bony chin characteristic of modern man.

Fig 1 Fossil jaws and teeth of *Australopithecus deyiremeda*. BRT-VP-3/1 (reversed) and BRT-VP-3/14 shown in occlusion. Note the massive mandible with antero-superior opening of the mental foramen, and significantly the serried hypoplastic ridges in the enamel of the maxillary canine and first premolar. (Reprinted by permission of Macmillan Publishers Ltd, from Haile-Selassie et al[6].)

Most significant are the serried hypoplastic ridges in the enamel of the maxillary lateral incisor, canine, and first premolar. These ridges are indicative of stages of disturbed amelogenesis during odontogenesis in infancy, recording disease or nutritional deficiencies having occurred in the holotype specimen.

Epigenetic events and the environment in which teeth are formed determine their morphology. The fact that teeth are the masticatory elements of ingested foods reveals the nature of diets and has enormous implications in identifying the culinary tastes and ecology of the ecosystem in which teeth are employed.[7]

The dietary component of comestibles and the cultural components of the culinary sciences are determinants of dentitions. Not only do teeth contain evidence of dietary intake, but also the encrustations of retained dental calculus reveal the contents of paleodiets.[8] The evolutionary processes bearing upon dental dimensions, enamel thicknesses, and attritional wear patterns as adaptations to dietary changes are embedded in tooth morphology.

The recent advances in deciphering the elemental components of enamel, dentin, and cementum by isotopic analyses provide astounding evidence of the nutritional status of not only the individual, but also of populations and their subsistence strategies. The emerging discipline of paleo-odontopathology indicates the levels of health and disease suffered by past generations. The components of DNA and RNA contained in the pulps of teeth invoke the evolutionary and genealogic relationships of individuals and populations.

As the most durable and enduring structures of human anatomy, teeth survive trauma, mutilation, fragmentation, partial incineration, and severe decomposition. As the needs for identification of human remains become more widespread with mass disasters and warfare, teeth are often the last resort and most reliable resource of recognition of recovered cadaveric material.[9]

The role of DNA recovered in the surviving pulps of teeth from victims of murder, mass calamities, or fire explosions is becoming indispensable as evidence of identity.[10] Moreover, the inheritance of genetic traits from generation to generation allows for DNA profiling of paternity, familial relations, races, and ethnic associations.[11]

It is now apparent that dental practitioners need to be aware of the widespread forensic implications of the evidence that can be elicited from the dentitions upon which they perform their therapeutic ministrations.[12] The charting record of missing teeth, restorations, and radiographs make every dentist an indispensable component of forensic investigating teams.

The imprints inflicted upon teeth during their formation serve as permanent markers of afflictions endured during fetal life and infancy. The classic defects of congenital syphilis such as Hutchinson incisors, Moon molars, and mulberry molars provide unmitigated evidence of maternal disease. Hyperthermia as an indicator of infectious diseases suffered in infancy can disturb the delicate processes of odontogenesis, imprinting defects of amelogenesis and dentinogenesis. Indeed, the very act of birth is defined in teeth by the dental neonatal line inscribing the transition of placental nutrition to oral feeding. The treatment of pediatric diseases by drugs, previously mercury and currently antibiotics, leave their mark on forming teeth. The tetracyclines are notorious for yellow staining of enamel if administered during infancy. The excessive dosage of fluorides producing enamel pitting and fluorosis blemishes are well-known indicators of ambient public health water supplies.

Finally, the impact of severe malnutrition and starvation during pregnancy and in the neonatal period engenders dental maldevelopment that endures throughout life.

The current craze for tooth whitening procedures that pervades the dental and dental hygiene professions creates cosmetic impacts upon teeth that characterize a lifestyle. Furthermore, artistry and embellishments performed on teeth to portray individuality or affiliation with an ethnic or tribal group have been formulated into rituals performed by societies. Thus, extraction of incisors to facilitate oral sex or the filing of teeth to indicate the completion of puberty rites are dental markers that make teeth part of societal acceptance (or rejection!). An enormous historiography pertains to this aspect of dental practice that extends beyond the current review of teeth, genes, and genealogy.

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