Effect of Geographic Variation in Bioarcheology: A Forensic Odontology Perspective

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The Journal of Contemporary Dental Practice (2024): 10.5005/jp-journals-10024-3630

“Forensic Odontology is a discipline of forensic science that deals with the proper management, analysis, and evaluation of dental evidence”. The evidence collected from the teeth aids in estimating the age of the individual and identifying the person to whom the teeth may belong.1 The primary emphasis is on bite marks found on crime victims. Tooth morphology, size, number, physical and chemical modifications, and tooth state (health) all contribute to the appraisal of finding evidence.2

“Bioarcheology, or Human Osteoarcheology, is the extensive study of human remains uncovered in archaeological contexts”. This discipline allows us to re-establish and analyze historical human activities, patterns of health, diseases, and other occurrences.3 Bioarcheology is a collection of academic disciplines that includes paleodemography, paleogenetics, and mortuary studies. Dental anthropology is a subfield that studies the use of teeth to address anthropological challenges. Teeth have many factors, ranging from those mostly regulated by genes (crown and root morphology and size, as well as missing and additional teeth) to those predominantly impacted by the environment (chipping, caries, periodontal disease, enamel hypoplasia, and so on).4

Questions in anthropology regarding teeth cover various aspects such as the origins and connections of populations (reflected in tooth shape, size, and count), developmental challenges (evidenced by hypoplasia and asymmetry), dietary habits and behaviors (seen in tooth wear, crown damage, and usage as tools), as well as overall dental health (including tooth decay, abscesses, gum disease, and tartar build-up).5 For more than a century, dental researchers have known that root architecture, tooth size, tooth morphology, and tooth number varied among human groups from different geographical regions. By 1960, it had been determined that the Indigenous Australians had the biggest teeth worldwide, unlike the San and Saami, who had the tiniest.6 Asians and their descendants were identified through their shovel-shaped incisors, whereas Europeans were characterized by the Carabelli cusp. This prompted investigators to carry out studies among different groups for several dental characteristics, revealing worldwide trends in dental diversity.

Africans have larger teeth with thicker enamel than Europeans, who have smaller teeth and less tooth mass. Asian and Native American people are more likely to have shovel-shaped incisors. Aside from variances in dental anomalies and morphology, there have been variations in dental development pace across populations. Europeans, for example, finish each stage of tooth development about 5% earlier. Koreans have the slowest rate of dental development, whereas Australians have the fastest, a distinction that has been related to both environmental and genetic influences.7–9

Genes have been linked to tooth formation. While it’s not possible to simplify normal dental variation to gene frequencies alone, studies involving twins and families suggest that the size and shape of teeth are features significantly influenced by heredity. Morphological characteristics showing polygenic diversity with semi-continuous inheritance manifest in either presence or absence and exhibit themselves in varying intensities. Missing third molars, formerly assumed to be a simple Mendelian trait, are now discovered to be quasicontinuous. Studies in evolutionary biology and developmental science have enhanced our understanding of the genetic and developmental factors affecting tooth dimensions and architecture.10

Diet and behavior also have an impact on tooth morphology and structure, as teeth wear down with use. Wear patterns are analyzed to deduce diet and eating habits. In hunter-gatherer societies, the front teeth, especially incisors, tend to wear down more quickly due to their frequent use in hide processing. In Inuit communities, where individuals often apply intense vertical forces during chewing and consume frozen or dried meat mixed with grit, it is common to see a high prevalence of chipping.11

Teeth are hardened versions of a protein blueprint, and their calcification can be influenced by both genetic and environmental factors. Consequently, scientists employ markers that imprint on teeth to investigate developmental irregularities caused by stress. The most prevalent indicator is linear enamel hypoplasia (LEH), which manifests as circumferential lines around a tooth. Because teeth form in relatively short periods of time, some authors base timing on the individuals’ biological age.12 Seasonal food constraint is the key driver of LEH development among northern hunting populations that live in tiny, remote communities with few endemic factors.
The interpretation of LEH lines, caused primarily by nutritional shortfalls or illness, is context-dependent, with different populations showing similar patterns for varied reasons. The elements listed above contribute to the accurate examination and interpretation of dental evidence in forensic odontology. A single tooth's morphology can help provide a realistic age estimate based on its development and wear. Because tooth size and shape are heavily impacted by genetics, teeth are more genetically informative than their skeletal counterparts. This suggests that data on dental morphology is essential for analyzing demographic affinities and evolutionary relationships. Teeth are also a great source of ancient DNA. Sometimes, unique or distinctive occlusion patterns, especially those visible on the front teeth, can aid in identifying individuals.

While tooth size is not a dependable indicator of ancestral background, variations in the morphology of dental crowns and roots among major human groups enable distinction at the levels of Asian, European, African, and their descendant populations. An online tool, rASUDAS, employing Bayesian analysis, has been crafted to evaluate the likelihood of categorizing a person into one of seven primary geno-geographical clusters. Thus, determining ancestry or race, as well as identifying geographical variations/features of teeth, greatly aids in the interpretation of forensic dental evidence.

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References