Journal of Pharmaceutical Research International

33(55A): 97-106, 2021; Article no.JPRI.77761
ISSN: 2456-9119
(Past name: British Journal of Pharmaceutical Research, Past ISSN: 2231-2919, NLM ID: 101631759)

Dental Anthropology-A Revolutionary Tool in Forensic Science

Anura Saher Raza [a≡], Amit Reche [b*ϖ], Kumar Gaurav Chhabra [b#], Priyanka Paul Madhu [bϖ] and Drishti Dixit [a≡]

[a] Department of Public Health Dentistry, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), Sawangi(Meghe) Wardha, India.
[b] Department of Public Health Dentistry, Sharad Pawar Dental College and Hospital, Datta Meghe Institute of Medical Sciences (Deemed to be University), India.

Authors' contributions

This work was carried out in collaboration among all authors. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/JPRI/2021/v33i55A33812

Open Peer Review History:
This journal follows the Advanced Open Peer Review policy. Identity of the Reviewers, Editor(s) and additional Reviewers, peer review comments, different versions of the manuscript, comments of the editors, etc are available here: https://www.sdiarticle5.com/review-history/77761

Review Article

Received 01 October 2021
Accepted 04 December 2021
Published 13 December 2021

ABSTRACT

Dental anthropology is a field of physical anthropology that studies the origin, development, and evolution of anthropoid dentitions, as well as their relationship to social, physical, and cultural factors. Teeth have their own distinct morphology and physiology, which is in stark contrast to the body's genetic structure. Teeth are also unique among the resistant elements of archaeological and fossil remains in that they have been exposed on the body's surface throughout their lives. As a result, dental anthropology may be assessed in the mouth cavity of living humans using similar methods to those used for prehistoric relics. As a result, it's no surprise that practising dental surgeons have historically ranked well among dental anthropologists.

This review's initial purpose is to provide an overview of the morphological and non-morphological properties of animate dentitions that aid in the indirect identification of prehistoric remains and the understanding of their cultural, social, and physical relationships, as well as to assist forensic odontologists with craniofacial identification and skull bone reconstruction.

[≡] *Intern;*
[ϖ] *Assistant Professor;*
[#] *Associate professor and Head;*
**Corresponding author: E-mail: dramitreche@gmail.com;*

Keywords: Dental anthropology; forensic anthropologists; metric tooth traits; snaggletooth; tooth wear.

1. INTRODUCTION

Anthropology, sometimes known as "human science," is the study of humans in all aspects of their existence, from their biology and evolutionary history to the social and cultural qualities that separate humans from other animals. Archaeology, physical anthropology, linguistic anthropology, social and/or cultural anthropology, and psychological anthropology were the diverse topics of research that separated anthropologists into specialisations [1].Physical anthropology includes a sub discipline called dental anthropology [1]. It is a crucial method of investigation that enables access to information that would otherwise be unavailable through other types of study. To determine and evaluate the era of existence of the species carrying those teeth, the topic entails analysing dental metrics and non-metric features similar to numerous cultural groups, tooth wear trends, and eating or other behaviours.

Because osseous remnants have a more delicate microscopic structure than teeth, they are more easily deteriorated. As a result, both in archaeological instances and in the sad rising number of mass tragedies, such as airline accidents, natural disasters, or terrorist acts, the latter frequently represent a significant component of the data accessible [2]. If police officers discover undocumented human remnants such as teeth, for instance, this crucial bit of evidence could be the only resource investigators have to match to dental records of reported missing individuals in order to ascertain the identity of the individual [3]. Because tooth material does not alter throughout a lifetime, it may be used to learn about past cultures' social and biological processes, as well as forensic anthropological methods for locating missing people. Modern Dental Anthropology is the outcome of years of systematic efforts by academic researchers to deepen the discipline's scientific nature and attempt to justify the tremendous biological variety of human groups [2].

2. HISTORY OF DENTAL ANTHROPOLOGY

The physical or biological anthropologist's job is to explain biological variety in terms of adaptation, evolution, and history. Anthropologists in the pre-Darwinian era concentrated mostly on racial diversity and classification. Blumenbach, Cuvier, and others concentrated on externally evident physical traits including skin, hair, and eye colour and form, as well as skull kinds, in their early classifications [4]. A small group of anthropologists began investigating the utility of teeth and their significance in understanding human health, behaviour, and variation in the nineteenth century [4].

More academics started paying attention to tooth size and morphology in primates, the still restricted variety of ancient hominins, and modern human populations after the post-Darwinian assumption that humans were primates and their closest relatives were apes [4].

2.1 Significance of Dental Anthropology

- It is significant in tracing historic trends in tooth size, shape, and number, genetically regulated variables such as tooth and crown size and morphology are used [2].
- Dental pathology and crown wear reveal dietary and cultural habits.
- It helps in defect analysis, both gross and microscopic, reflects disease and dietary stress.
- The intentional cultural changes of teeth (dental scarification) reflect people's past and present societies and cultures.
- Bite marks, specific occlusion and wear patterns, missing and filled teeth, and radiographic markers make teeth crucial in many forensic investigations.
- The comparative anatomy of teeth is important for identifying biology and systematics.

2.2 Objectives of Dental Anthropology

- Dental anthropology is valuable not just for exploring the past, but also has an impact on clinical fundamental research. For instance, recognising evolutionary tendencies, such as the decrease in the size of teeth and jaws has crucial implications and consequences for dental practise which makes it essential, to have a knowledge of dentition size and form variation, as well as how to interpret it in

terms of sexual dimorphism, evolution, migration, and growth [2].

- The reconstruction of anthropoid and primate phylogenetics being one of the goals of dental anthropology.
- Anthropologists study ancient, fossil, and forensic remnants in hopes of learning more about the biology of early human civilizations' and to monitor their evolution. Throughout evolution, it has been vital to differentiate one individual from the rest of the species using their shattered remnants, particularly teeth. Teeth are one of the most resistant anatomical elements of fossil skeletons, having been subjected to a variety of stresses during the span of a person's life for which it is necessary to clearly identify all aspects of the human jaws and dentition and to label the primary features of each tooth [5].
- To have a knowledge of the developmental mechanisms that lead to the construction of the Jaws and teeth and to have a better understanding of the many forms of wear and how they change with age.
- To be able to recognise the essential microscopic characteristics in the histology of enamel, dentine, and cement, as well as to comprehend the primary methods in which they may be utilized in anthropological study and also make use of these characteristics to define the most common forms of dental pathological lesions, as well as understand how they are assessed.
- To have a firm grasp on the significance of dentition in determining age.

3. STEPS OF DENTAL ANTHROPOLOGY IMPLEMENTATION

3.1 Collection and Handling

Following proper collection and recording of the remains of a skeleton with teeth, as well as thorough and gradual analyses of the sediment around it for disintegrated teeth or bones, the collected specimen must be transported with extreme caution to avoid fragmentation of fragile parts such as the mandible, and metric and non-metric analysis in the laboratory [2].

3.2 Metric Analysis Methods

Various methods for measuring teeth have been presented by researchers. The size of the teeth is generally determined by characteristics such as height and length, also measured are the diameter, width, and area. Characteristics such as height, for example, are not measured since the teeth of ancient humans are heavily worn, making the height useless and incomparable to other specimens. Because it uses commonly defined measuring points and methodologies, metric analysis is an effective method for facilitating specimen comparison. Each tooth size falls into a certain ethnic group's typical size category. As a result, a suitably sized sample can disclose the metric size of one group. Digital callipers must be used to measure teeth, and four attributes must be measured. By measuring one object twice and re-measuring pairs of measurements with considerable discrepancies, an average value in millimetres (mm) is determined [2].

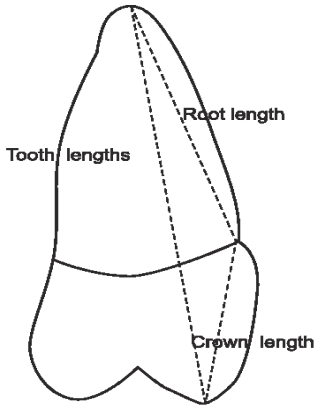


Fig. 1.

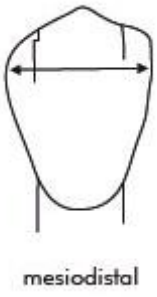


Fig. 2.

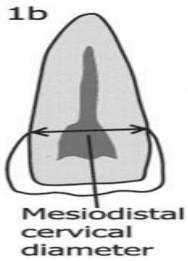


Fig. 3.

a. Crown length

It is determined by measuring the distance between the
tooth's facial surface, bend ridge, and cutting edge (front tooth)
or protoconid cusp top (molar).

b. Mesio-distal diameter

The longest distance between the bend ridge inside
the crown and the distal surface bend ridge parallel to
the face surface of the teeth is used to determine the crown's diameter.

c. Crown cervix mesio-distal diameter

This is the shortest distance between the inner surface of the crown and the tooth root boundary, as well as the distal surface parallel to the teeth's face surface.

d. Facio-lingual diameter of the crown

The longest distance between the bend ridge of the face surface and the metaconid bend ridge is measured perpendicular to the surface where the mesio-distal diameter of the teeth was measured(6).

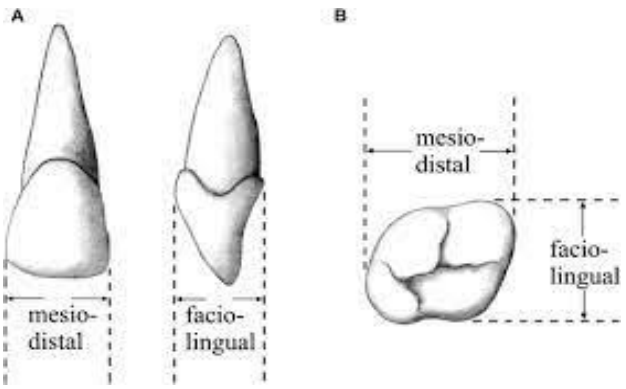
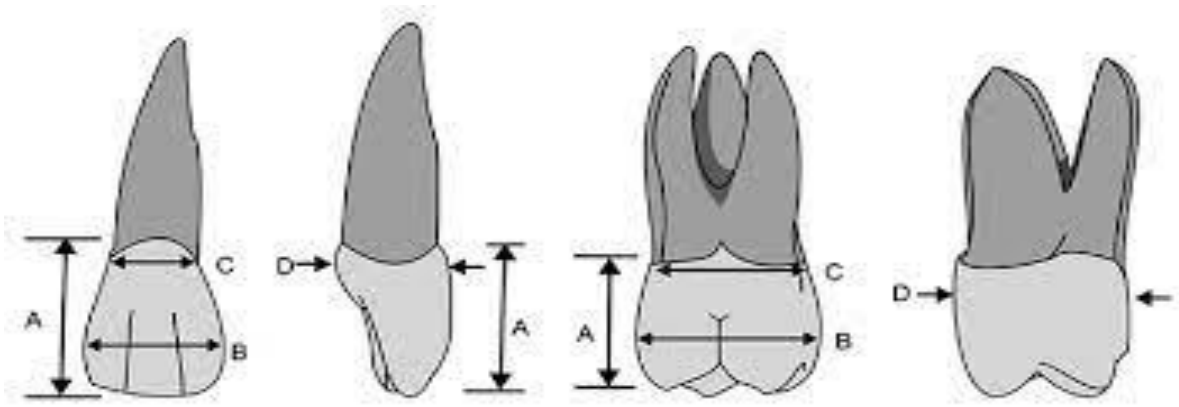


Fig. 4.



A-CROWN LENGTH
B-MESIO DISTAL DIAMETER,
C- MESIO DISTAL DIAMETER OF THE CROWN CERVIX,
D-FACIO LINGUAL DIAMETER OF THE CROWN

Fig. 5.

e. Module of the crown (mcor)

This is the head's relative size, which may be computed using the average of the facio-lingual and mesio-distal diameters. The complete size is normally only estimated when crown height is taken into account, despite the fact that the height value that may be determined by wearing of the tooth is limiting.

As a result, the mcor is utilised in order to make a comparative or informative comparison. For today's individuals, consider the following:

- Southern Europeans have a little tooth type of 10.20 mm.
- Mongoloids and Northern Europeans have a middle tooth type of 10.20-10.49 mm.
- Groups primarily residing in tropical locations and the South Pacific have enormous tooth types (> 10.50 mm).

e. Index of the crown (I cor)

This is the ratio of the molar crown's mesio-distal diameter to the facio-lingual diameter. When viewed from the top, the crown seems longer in the facio-lingual direction because the index is greater.

f. Crown absolute size (robustness, Rb)

This is a paleoanthropological metric that measures the overall crown size in relation to the crown module.

g. Crown size in relation to others(canine index, incisor index)

This includes the ratio of mesial incisor mesio-distal diameter to maxillary lateral incisor mesio-distal diameter, as well as the ratio of mesial canine length to mandibular lateral mesio-distal diameter.

- Over the course of human evolution, the first molar is thought to be the tooth that has had the least amount of change (Selmer-Olsen 1949). Because it is the least affected tooth, the mesiodistal width retains its genetic characteristics the best among metric qualities.
- The step-index is determined as the proportion between the first molar's mesio-distal diameter to that of canines, second, and third molars based on these parameters. When compared to the first molar, the deterioration of those teeth can be estimated.

4. NON-METRIC ANALYSIS METHODS

Non-metric dental traits are morphological aspects of the teeth that vary in appearance both within and between populations. These characteristics appear to be influenced by genetics in part, therefore they can be successfully employed in the description of ethnicity, which can aid in the identification of a person through dental data. The majority of them are found in the crowns of incisors and molars in

both dentitions. Teeth non-metric features are useful for identifying modern human groupings and determining their genetic ties with ancestral populations [7]. The number and position of teeth, as well as the diversity of tooth shape, are used to classify non-metric features [8]. The tooth trait's diversity provides crucial identifying information that distinguishes genetic recombination, and helps in establishing links between small populations [9]. Non-metric traits that are frequently reported include:

a. Congenitally missing teeth:

- The third molar and maxillary lateral incisors are two teeth that are frequently absent.
- In many situations, the incisors next to the eye tooth (canine) look identical when lateral incisors are congenitally lacking.
- This phenomena has been more common during the previous millennium, with some groups reporting a frequency of up to 20% in some cases.

b. Snaggletooth

- It might be an incisor or a molar, and its form might or might not be the same as a regular tooth.
- It can affect both permanent and deciduous teeth, but the latter is far less common.

i.Bi-laterally rotated incisors (winging) –

- The 'twisting' of the mesial side of the incisors toward the cheek is more typical in the lateral incisors. V-shaped or wing-shaped teeth are other names for them.
- The Mongoloid group has an expression rate of up to 45 percent, however this is uncommon among Europeans.

ii .Peg-shaped teeth

• These teeth are disproportionately tiny and resemble pegs; these are most common in the maxillary lateral incisors and may be caused by a congenital abnormality.
• In hominid populations, the expression frequency is around 3%, and it is somewhat greater in Europeans.

iii. Crowding of teeth

- When teeth that are permanent become overcrowded, one or two are usually forced out of their normal locations. Because the tooth sizes remain constant while the jaw size decreases, this results in crowding.
- As a result, the alveolus shrinks, preventing teeth from erupting correctly and causing them to spin. This condition is more common in maxillary incisors.

iv. Shovel-shaped incisors (shovelling)

- Among the morphological qualities of teeth, this genetic characteristic is the most widely investigated. Shovelling is the stretching of the enamel of the mesial and distal incisors' edges toward the tongue.
- The border of enamel is formed by this lingual edge ridge, which creates a fossa in the lingual centre [10].

v. Double-shovelling, labial marginal ridges (double-shovelling, labial marginal ridges)

- The enamel on the mesial and distal edge ridges of maxillary incisors that reach toward the cheek and tongue is referred to as double shovelling.

c. Canine distal accessory ridge

- This characteristic refers to the supplementary ridge on the lingual side of the mandibular canine's distal surface.

d. Terra's tubercle

- This extra tubercle can be found on the edge ridge of the maxillary first canine's inner surface.

e. Carabelli's cusp

- Tubercle with an unusual shape. The lingual surface of the protoconid of the maxillary first molar is where Carabelli's cusp is located. The fifth cusp is also a name for it.

f. Protostylid cusp

- A protostylid cusp is an auxiliary cusp that forms in front of the mandibular molar's buccal side.

g. Premolar groove patterns

- The number and form of lingual cusps in maxillary and mandibular premolars are studied.

h. Cusp patterns of molars

- Molar cusp form and grooves have been used to characterise traits among modern human groupings, such as ties between ancestors and descendants.

i. Mandibular molar occlusal cusp type

- The number of cusps and grooves determine the occlusal cusp type of mandibular molar.
- Depending on the groove type, there are usually 4-5 cusps.
- Grooves are divided into three categories: T, Y, and X.

j. Mandibular molar distal trigonid crest

- The existence of the crest linking the protoconid metaconid of the trigonid of mandibular molars is noted.

k. Deflecting the wrinkle of the mandibular molar lingual front cusp

- The metaconids occlusal ridge on mandibular molars usually runs straight from the cusp top into the developing groove. This ridge can be straight and refracted by being slanted toward the central fossa in some circumstances. This is an unusual occurrence in the third molar.

l. LEH

- Due to the limits of dental asymmetry as a large scale predictor of comparative stress levels, dental anthropologists have moved their focus to the study of abnormalities in the tooth crown that occur during amelogenesis (enamel development) and dentinogenesis (dentine production) (dentine formation) [11].

5. SIGNIFICANCE OF DENTAL ANTHROPOLOGY IN FORENSICS

Without a doubt, forensic odontologists all around the world have positively identified a huge majority of the victims discovered at crime scenes throughout the years. They did so by dissecting/resecting jaws from scarred and decomposing victims, comparing ante-mortem and post-mortem dental radiographs, and investigating bite marks inflicted on one individual by another. Although forensic anthropologic tests seldom result in a direct identification, they can substantially aid in narrowing the search field, which may lead to an identification. Odontology is one area of forensic investigation that rarely requires non-clinical assistance, except in situations when teeth are severely fractured and commingled [12]. Forensic dental anthropologists use their experience in the recovery and reconstruction of human remains to identify and recreate dentitions, making them more suitable to examination by forensic odontologists.

6. FUTURE DIRECTIONS IN FORENSIC ANTHROPOLOGY

Forensic anthropology requires varying approaches of anthropological knowledge to solve medical and legal issues. While these approaches are based on facts, the scientific technique and basis have been built through many years of research and experience [13]. The technique has evolved via experimentation, the compilation of recorded collections and databases, and careful study design. Casework-related concerns have fueled a lot of this advancement. However, the specific difficulties raised by casework are sometimes inadequately resolved by conventional methodologies. These problems motivate forensic anthropologists to do specialised study in order to find new alternatives.

6.1 Assessment of Skeletal Evidence on a Molecular Level

Molecular analysis can offer very precise information on the sex of the subject portrayed and enable positive identification in the field of forensic anthropology. The identification of species and the study of ancestry of a species can both benefit greatly from molecular analysis techniques. The use of DNA for accurate identification has had a significant

influence on forensic anthropology and other forensic science disciplines.

6.2 Facial Imaging

Forensic anthropologists address challenges such as face approximation, craniofacial photographic superimposition, and surveillance picture interpretation. The method of determining a person's living facial appearance from the facts supplied by a found skull is known as facial approximation. This tactic is used to reach out to the general public for missing person leads that might lead to identification through other means.

6.3 Analysis of Isotopes Found in Diet

For decades, elemental stable isotope analysis has provided crucial anthropological information on food. Stable carbon isotopes extracted from human tissues indicated whether the diet centred on plants with a C3 photosynthetic pathway or plants with a C4 photosynthetic pathway, as well as the herbivores that ate them. Such data is critical for interpreting food and horticulture patterns in anthropological studies of ancient cultures. Isotopic analysis principles have recently been used to investigate the geographical origin of human remains. When unexplained human remains are discovered in forensic contexts, investigators wonder if they belong to someone who lived in the location where the remains were discovered or someone who lived elsewhere.

6.4 Research on Decomposition

Decomposition study has been the subject of major new projects in forensic anthropology. Research involving both people and non-human animals has disclosed a lot about the process of soft tissue disintegration and hard tissue change, including how it varies. In general, such study has shown the numerous elements that impact the nature and timing of breakdown. Temperature and location (surface, in-ground, aquatic, etc.) have long been thought to be important considerations. Soil conditions, moisture, body composition, body condition, the presence of clothes or enclosures, funerary care, and a variety of other elements have all been found to impact the process. Such data is required to accurately estimate the period since death (post-mortem interval) and post-mortem occurrences involving criminal behaviour.

6.5 Tooth Wear Patterns in Dental Anthropology

Tooth wear is a natural physiological phenomena in which teeth remain effective while being worn. Differences in the abrasiveness of the food and the usage of teeth as tools are linked to the intensity and type of tooth wear among civilizations [14].Tooth loss is inextricably linked to survival in species that utilise teeth to digest food - lose your teeth, and you lose your life. In the latter phases of human development, cultural buffering helped to remove this major link, although dental problems are still governed by long-term evolution, not current cultural improvements [15]. As a result, human teeth, like the teeth of other vertebrates, were created under the influence of the environment. Anthropologists have long focused their understanding of tooth wear in pre-modern civilizations on the abrasiveness of the diet, sociocultural behaviours, as well as the usage of teeth as a means to cut, tear and grind the food. Because due to the use of processed and softer foods, modern people have less abrasive wear. As a result, erosion and attrition account for a large portion of the wear in our modern civilizations. Dental occlusions are fluid and change throughout time. The principal factor that affected the morphology of teeth through time was tooth wear, notably abrasion in pre-modern hunter-gatherer groups. Since the reptilian-mammalian transition, tooth wear mechanisms, particularly abrasion, have been prevalent. In contrast to the anthropological perspective [16].

It's plausible to say that dentistry developed as a science during the preceding century, when dental caries, periodontal disease, and damaged dentitions were wreaking havoc on communities. As a result, dentistry has advanced in its ability to restore and rehabilitate dentitions to their original morphology, based on the underlying assumption that the newly erupted tooth was the most useful form. Despite the fact that dental thought is shifting away from strict geometric notions, there was a time when any sort of tooth wear was deemed problematic [17].There is little doubt that dental anthropology and dentistry are becoming more intertwined. Dentists are shifting away from static concepts, affirming significant changes as an implacable progression throughout life. Anthropologists have widely accepted attrition, abrasion, and erosion as distinct mechanisms.

7. CONCLUSION

The state of one's teeth may reveal a lot about one's diet and overall health. The evidence of food texture may be seen in macroscopic wear and dental micro wear studies. Trace element bio monitoring aids in determining a person's nutritional and environmental state. It's critical to develop Dental Anthropology's varied spirit. Dentists, physicians, bio archaeologists, forensic anthropologists, biochemists, biologists, historians, and social anthropologists all have knowledge and abilities that can help broaden the spectrum of interpretations within the subject. It is clear that the metric and non-metric characteristics of teeth may play a significant influence in anthropology. Thus, modern dental anthropology is the result of decades of planned and continuous efforts by research teams to develop the discipline's scientific nature and seek to explain the tremendous biological variety of human communities.

CONSENT

It is not applicable.

ETHICAL APPROVAL

It is not applicable.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Anthropology | Definition, Meaning, Branches, History, & Facts | Britannica [Internet]. [cited 2021 Nov 12]. Available:https://www.britannica.com/science/anthropology
2. Shah S, Wasti A. Analytical Methods of Dental Anthropology & Forensic Odontology –An Overview. Glob J Res Anal. 2021;190–9.
3. Overview of Forensic Anthropology and Forensic Dentistry [Internet]. National Institute of Justice. [cited 2021 Nov 12]. Available:https://nij.ojp.gov/topics/articles/overview-forensic-anthropology-and-forensic-dentistry
4. Scott G. A Brief History of Dental Anthropology. In 2015:7–17.
5. Scott G. Dental Anthropology. In; 2017.
6. Kaidonis J, Ranjitkar S, Lekkas D, Townsend G. An Anthropological Perspective: Another Dimension to Modern Dental Wear Concepts. Int J Dent. 2012 Dec 10;2012:741405.
7. Alt K, Brace C, Türp J. The History of Dental Anthropology. In 1998:S.15-40.
8. Deolia SG, Chhabra C, Chhabra KG, Kalghatgi S, Khandelwal N. Dental anomalies of the deciduous dentition among Indian children: a survey from Jodhpur, Rajasthan, India. J Indian Soc Pedod Prev Dent. 2015;33(2):111–5.
9. Sreenivasan PK, DeVizio W, Prasad KVV, Patil S, Chhabra KG, Rajesh G, et al. Regional differences within the dentition for plaque, gingivitis, and anaerobic bacteria. J Clin Dent. 2010; 21(1):13–9.
10. Min-Kyu P. A method for studying human teeth excavated in archaeological sites: A focus on recent research sites. Anthropol Noteb. 2017;23:5–19.
11. Wilkinson C. Facial reconstruction--anatomical art or artistic anatomy? J Anat. 2010;216:235–50.
12. Schmidt CW. Forensic dental anthropology: issues and guidelines. In: Nelson GC, Irish JD, editors. Technique and Application in Dental Anthropology [Internet]. Cambridge: Cambridge University Press; 2008 [cited 2021 Nov 12]:266–92. (Cambridge Studies in Biological and Evolutionary Anthropology). Available:https://www.cambridge.org/core/books/technique-and-application-in-dental-anthropology/forensic-dental-anthropology-issues-and-guidelines/6E58BF3C5CD503648274523386F521B8
13. Ubelaker DH. Recent advances in forensic anthropology. Forensic Sci Res. 2018;3(4):275–7.
14. Kaidonis JA. Tooth wear: the view of the anthropologist. Clin Oral Investig. 2008;12(Suppl 1):21–6.
15. Aubry M, Mafart B, Donat B, Brau JJ. Brief communication: Study of noncarious cervical tooth lesions in samples of prehistoric, historic, and modern populations from the South of France. Am J Phys Anthropol. 2003; 121(1):10–4.
16. Bell EJ, Kaidonis J, Townsend G, Richards L. Comparison of exposed dentinal surfaces resulting from abrasion

and erosion. Aust Dent J. 1998;43(5): 362–6.

17. Teaford MF, Walker A. Quantitative differences in dental microwear between primate species with different diets and a comment on the presumed diet of Sivapithecus. Am J Phys Anthropol. 1984; 64(2):191–200.

Peer-review history:
The peer review history for this paper can be accessed here:
https://www.sdiarticle5.com/review-history/77761