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Tooth evolution and its effect on the malocclusion in modern human dentition*

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Abstract

Human evolution refers to the natural process of all human clade members involved in evolutionary history. Modern humans' orofacial complex and the masticatory system evolved from their ancestors to the current state of hominins. The preservation of teeth in the fossil record makes these small organs essential for the work of palaeontologists and anthropologists. Furthermore, with the recent discovery and scientific development in dentistry, teeth have become of interest to the fields of regenerative medicine, aesthetics, and orthodontic treatment. From the perspective of anthropology studies, tooth evolution is associated with various anatomical and structural changes in the human body. Malocclusion in modern humans has been predicted as a result of tooth evolution linked to food processing and consumption. Tooth evolution affects the incisor-canine complex that lies behind the upper arch, decreases pneumatization of the frontal sinuses, moves the temporomandibular joints forward, and reduces jaw size. These changes cause the dentition to deviate from normal occlusion, resulting in tooth crowding, protrusion, or malposition.

Keywords: evolution; food consumption; food processing; humans; malocclusion

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Introduction

Evolution is defined as the gradual change in an organism's structure to achieve functional conformity with the time and place of its life (1,2). Human evolution can affect anatomical and histological changes in the body, including the masticatory system. Various changes in the orofacial region have been attributed to evolution, including the reduction of the human jaw and teeth, the temporomandibular joint, and the capacity of masticatory muscles (3,4).

Dietary changes as one of the evolution processes resulted in smaller, less prominent jaws, smaller teeth, and non-projected canines in the Homo sapiens (4,5). These changes in the modern human's masticatory system frequently result in various issues, such as tooth agenesis, impacted teeth due to a lack of space for teeth to erupt, and malocclusion (6). This review aims to discuss the effect of tooth evolution on the incidents of malocclusion in modern humans. An online literature search was conducted in this review including studies and article reviews on the evolution of human dentition and dental malocclusion.

Brief History of Human Evolution

Human evolution refers to the natural process of all human clade members involved in evolutionary history (consisting of Homo and other members of the human tribe, Hominin, after the split from chimpanzees and bonobos) (7). The documented size of hominin jaws and teeth has been reduced over the last 2.5 to 5 million years due to better cutting, crushing, and grinding tools and techniques, as well as the use of fire for cooking, but these effects cannot be precisely attributed (8). Early hominin skulls resemble those of apes rather than humans. Great apes have large jaws and a small braincase. Ape canine teeth are broad and pointed, projecting beyond the other teeth; lower premolars in apes and many primates are unicuspidal and sharpen the upper canines to a sharp tip (9).

In male Australopithecus and Paranthropus, the large chewing muscles required to power the deep, robust jaws were attached to prominent crests on the brain and flaring bone arches on the face and sides of the skull. While the incisors and canines shrank over time, Paranthropus' posterior teeth grew in size. As a result, P. robustus and P. boisei have relatively flat faces and non-protruding jaws. Australopithecus species also had large posterior teeth, but their faces were more protruding because their incisors and canines were less reduced than those of Paranthropus. The size of the posterior teeth gradually increased from A. anamensis to A. africanus and H. habilis, with A. afarensis being intermediate between A. anamensis and the younger Australopithecus species (8).

Patterns of tooth wear in A. afarensis suggest that it may have been removed from vegetable foods by manually pulling them across the front teeth. The gracile-skulled Australopithecus may have consumed more problematic foods than the robust-skulled Paranthropus. Furthermore, some paleoanthropologists believe that Paranthropus was a vegetarian, whereas A. africanus consumed more meat. P. robustus ate hard foods, and Kenyan P. boisei chewed whole pods and fruits with hard coatings and hard seeds, though they did not chew grass seeds, leaves, or bones in large quantities (10). The teeth of Homo became smaller over time, unlike those of Paranthropus and Australopithecus. H. rudolfensis, even relative to estimated body size, has large rear teeth, but H. ergaster approaches the modern human condition. The face of H. rudolfensis is, at the same time, more like that of Australopithecus than that of H. ergasterz (8).

Evolution and Malocclusion in Modern Human and the Occlusal Conditions of Homo Sapiens

Homo sapiens is well-known for its incisor-canine complex behind the upper arch and reduced pneumatization of the frontal sinuses. In humans, the occlusal plane is not always horizontal. A helicoidal occlusal plane is a tooth inclination in which a plane sloping upward palatally shows the anterior cheek teeth and a plane sloping upward orally forms a twisted occlusal plane for the more posterior teeth. Although the helicoidal occlusal pattern has been thought to be unique to the Homo orofacial region, it has also been observed in Pleistocene hominids and non-human primates, particularly chimps (11,12).

The dental arcade in molar hominids was foreshortened primarily posterior to the root of the zygomatic arch and medially to the masseter-pterygoid complex. Both factors appeared to be necessary for the development of the helicoidal occlusal plane. The axial inclination of the molar roots was also required to reduce the dental arches and their retraction under the cranium. It has been proposed that differential changes in cusp heights have paralleled this axial inclination of the teeth during evolution to keep the chewing complex functional. Human posterior teeth in the sagittal plane are also inclined. Human lower third molars have shifted forward during evolution as a result of temporomandibular joint displacement about the occlusal plane. This resulted in the development of the curve of Spee, which is more pronounced in humans than in other hominids. Despite their disadvantageous position, the third molars became functional as a result. It has been stated that molars on the working side function in a smooth gliding motion due to this curve. Molars work in series rather than simultaneously. Furthermore, the third molars continue to play an important role in the complex relationship between the curve of Spee and the helicoidal occlusal plane (4).

The joint has moved forward in Homo sapiens, but it has retained the same elevation distribution as in Neanderthals. Hominoids' mandibular condyles occupy a restricted position in the occlusal plane. When the jaws are closed, different positions (high, low, forward, and backward) have a significant impact on the lower molar movements and how food is processed during chewing. During human evolution, there were fairly well-defined changes in temporomandibular joint position, which were most likely related to changes in food processing and diet (4,13,14).

Malocclusion in Modern Human Dentition

A malocclusion is a type of occlusion that differs from the standard form, considered the usual form. Occlusion is expected if the teeth are properly arranged and the upper and lower teeth have a harmonious relationship. Malocclusion is not a disease but can disrupt chewing, swallowing, speech, and facial harmony, resulting in physical and mental disorders if left untreated. Individuals and the social environment are significantly impacted by malocclusion in terms of comfort, quality of life, social limitations, and functions (15,16).

Malocclusion is common in today's population. The anterior crossbite is the most common condition, affecting 4-5% of the population during the early mixed dentition stage. Most of the evidence comes from orthodontic studies in modern pre-industrial populations, which have a lower prevalence of malocclusion than the modern population. Aside from having a lower prevalence, the severity is also lower. The rise in malocclusion is closely linked to the evolutionary process, which is caused by increased genetic variability in mixed-race populations or the evolution of dietary and intelligence patterns (17). Human evolution has been linked to genetic factors from preliterate to modern times. According to Sarig et al. (2013), malocclusions are a common issue in the modern population. However, in modern primitive or pre-industrial populations, disproportionately large jaws and teeth are uncommon (17–19). In modern humans, tooth crowding or multiple diastemas result from tooth and jaw size disproportion. Discord in jaw relationships results from differences in the size, position, and shape of the upper and lower jaws (17,20).

Mixed marriage is also predicted to be a factor in the rising prevalence of malocclusion in modern society. Polymorphisms and genes influence a variety of genetic factors, including muscle fiber plasticity and jawbone morphology. According to a study by Mockers, 2004, dental crowding is caused by normal-sized teeth growing in small jaws (21). Aside from interbreeding, diet evolution has also influenced the evolution of pre-modern and modern populations' oral cavities. An examination of tooth shape, tooth size, enamel structure, and dental microwear revealed that the food capacity of early hominin/Australopithecus species differed from that of today's homo sapiens. Because Australopithecus had large, blunt teeth, he could eat hard objects like fruit, flowers, and pea shoots (4).

The transition to modernization indicates a shift from a hunter-gatherer society to an agricultural economy. Easier food preparation, such as cooking, loosens up the chewing system and causes a mutation effect, which may result in reduced tooth size. The next influence is related to the evolution of human intelligence. Growing brain size increases human ability, which is then passed down genetically to future generations. Humans can now coordinate their actions to provide food and improve foraging abilities. Humans can cook and soften their food, making chewing less efficient. The agricultural and industrial revolutions resulted in smaller jaws and less-toned muscles of the face and oropharynx, which contribute to the prevalence of serious health issues such as cardiovascular disease, cancer, and dementia, increasing morbidity rates (22).

Human teeth and jaws change as a result of evolution, which leads to malocclusion. In today's society, various problems with the human masticatory system, such as dental crowding, protrusion, crossbite, impacted, and ectopic teeth, are common. Impacted teeth are defined as teeth that are unable to erupt because of a lack of space in the jaw or bone obstruction in the impaction area. The maxillary canines, maxillary third molars, and mandibular third molars are the most commonly impacted teeth. Impacted third molars on the mandible are frequently associated with insufficient mandible size for third molar growth. Furthermore, the length of the mandible, as well as the difference in size between the dental arch and total tooth size, were factors that contributed to the placement of impacted third molars (23).

Dental crowding is a condition in which the teeth are not correctly aligned. It is caused by a basalt curve that is too small in comparison to the coronal curve. The basal arch is the arch in the alveolar process where the tooth's apex is embedded, while the coronal arch is the widest. The severity of dental crowdedness is divided into two categories: lightly crowded and heavily crowded. Lightly crowded teeth are those that are slightly congested and are commonly found on the front mandibular teeth. They are considered a normal variation of human dentition. Heavy tooth crowding is common in the tooth period mixture, where the occlusion is still typically temporary and not static. As a result, now is an excellent time to diagnose crowded teeth and perform the inter-septicortodontic treatment to prevent malocclusions from forming during tooth eruption (24).

Dental crowding is the most common reason for patients seeking orthodontic treatment. Orthodontic treatments are unsurprisingly popular among modern humans. The prevalence is estimated to be between 70 and 80%. Crowded teeth are the result of an evolutionary trend toward smaller jaw sizes that have not been accompanied by a corresponding decrease in tooth dimensions. The process is linked to the need for mastication as a result of nutritional changes, dietary excess, and genetic influences, according to most experts. Data show that dental crowding affects only 1% of bronze-age humans and 10% of 16th-century people (25,26).

Conclusion

The evolution of teeth in humans is caused by changes in diet and some internal factors such as bad habits, so the shape of the jaws and teeth has changed over time. Modern human teeth and jaws have the incisor-canine complex behind the upper arch, reduced pneumatization of the frontal sinuses, temporomandibular joints movement forward, and jaw shrinkage. These changes cause malposition abnormalities, which lead to impaction and ectopic teeth. Thus, the evolution of human teeth and jaws can result in malposition abnormalities such as impactions and ectopic teeth.

Conflict of Interest

The authors have no conflict of interest to declare.

Authors' contributions

The authors contributed to this work, as follows: AK, AC, MSM, BNR, and BFWP contributed to the conception and design of the review. AK, PSJ, and IPR contributed to the acquisition of data. AK, MSM, BNR, AY, and AM contributed to drafting and revising the article. AK is the supervisor of the present study. All authors have read and approved the final manuscript.

References

1. Kurniawan A, Moza SM, Nuraini N, Hanif MA, Sekar DA, Talitha P. Lifestyle changes and its effect towards the evolution of human dentition. Egypt J Forensic Sci. 2022;12:8. doi: 10.1186/s41935-022-00268-4.
2. Das H, Motghare V, Singh M. Human Evolution of the Teeth & Jaws: A Mouthful of History. Int J Oral Heal Med Res. 2019;5:32–36.
3. Luca F, Perry GH, Di Rienzo A. Evolutionary adaptations to dietary changes. Annu Rev Nutr. 2010;30:291–314. doi: 10.1146/annurev-nutr-080508-141048. Cited: in: : PMID: 20420525.
4. Emes Y, Aybar B, Yalcin S. On The Evolution of Human Jaws and Teeth: A Review. Bull Int Assoc Paleodont. 2011;5:37–47.
5. Gkantidis N, Tacchi M, Oeschger ES, Halazonetis D, Kanavakis G. Third Molar Agenesis Is Associated with Facial Size. Biology (Basel). 2021;10:650. doi: 10.3390/biology10070650.
6. Shah AP, Parekh PA. An Evaluation of Genesis and Impaction of 3rd Molar in Adolescents. Int J Med Dent Sci. 2014;3:329. doi: 10.19056/ijmdsjssmes/2014/v3i1/80692.
7. Veldhuis D, Kjærgaard PC, Maslin M. Human Evolution: Theory and Progress. Encycl Glob Archaeol. New York, NY: Springer New York; 2014. p. 3520–3532. Available from: http://link.springer.com/10.1007/978-1-4419-0465-2_642.

8. Tuttle RH. Human Evolution. Encycl. Br. 2022 [cited 2022 Sep 22]. Available from: https://www.britannica.com/science/human-evolution.
9. Wood B. Colloquium paper: reconstructing human evolution: achievements, challenges, and opportunities. Proc Natl Acad Sci U S A. 2010;107 Suppl:8902–8909. doi: 10.1073/pnas.1001649107. Cited: in: : PMID: 20445105.
10. Scott RS, Ungar PS, Bergstrom TS, Brown CA, Childs BE, Teaford MF, Walker A. Dental microwear texture analysis: technical considerations. J Hum Evol. 2006;51:339–349. doi: 10.1016/j.jhevol.2006.04.006.
11. Malassé A. The relationships between occlusion and posture in the hominid lineage, implications for the transition between mesolithic and neolithic populations. Int J Mod Anthropol. 2010;1. doi: 10.4314/ijma.v1i3.60334.
12. Buck LT, Stringer CB, MacLarnon AM, Rae TC. Variation in Paranasal Pneumatisation between Mid-Late Pleistocene Hominins. Bull Mem Soc Anthropol Paris. 2019;31:14–33. doi: 10.3166/bmsap-2019-0056.
13. Allen KL, Cooke SB, Gonzales LA, Kay RF. Dietary inference from upper and lower molar morphology in platyrrhine primates. PLoS One. 2015;10:e0118732. doi: 10.1371/journal.pone.0118732. Cited: in: : PMID: 25738266.
14. Kaidonis JA, Ranjitkar S, Lekkas D, Townsend GC. An anthropological perspective: another dimension to modern dental wear concepts. Int J Dent. 2012;2012:741405. doi: 10.1155/2012/741405. Cited: in: : PMID: 23304146.
15. Kumar DA, Varghese RK, Chaturvedi SS, Agrawal A, Fating C, Makkad RS. Prevalence of Malocclusion Among Children and Adolescents Residing in Orphanages of Bilaspur, Chattishgarh, India. J Adv Oral Res. 2012;3:18–23. doi: 10.1177/2229411220120304.
16. Marini MI, Angrosidy H, Kurniawan A, Margaretha MS. The anthropological analysis of the nasal morphology of Dayak Kenyah population in Indonesia as a basic data for forensic identification. Transl Res Anat. 2020;19:100064.
17. Sarig R, Slon V, Abbas J, May H, Shpack N, Vardimon AD, Hershkovitz I. Malocclusion in Early Anatomically Modern Human: A Reflection on the Etiology of Modern Dental Misalignment. Frayer D, editor. PLoS One. 2013;8:e80771. doi: 10.1371/journal.pone.0080771.
18. Major PW, Glover K. Treatment of anterior cross-bites in the early mixed dentition. J Can Dent Assoc. 1992;58:574–575, 578–579. Cited: in: : PMID: 1511366.
19. Hannuksela A, Väänänen A. Predisposing factors for malocclusion in 7-year-old children with special reference to atopic diseases. Am J Orthod Dentofacial Orthop. 1987;92:299–303. doi: 10.1016/0889-5406(87)90330-1. Cited: in: : PMID: 3477948.
20. Sasaki K, Hannam AG, Wood WW. Relationships Between the Size, Position, and Angulation of Human Jaw Muscles and Unilateral First Molar Bite Force. J Dent Res. 1989;68:499–503. doi: 10.1177/00220345890680031401. Cited: in: : PMID: 2921394.
21. Mockers O. Dental crowding in a prehistoric population. Eur J Orthod . 2004;26:151–156. doi: 10.1093/ejo/26.2.151.
22. Kahn S, Ehrlich P, Feldman M, Sapolsky R, Wong S. The Jaw Epidemic: Recognition, Origins, Cures, and Prevention. Bioscience. 2020;70:759–771. doi: 10.1093/biosci/biaa073. Cited: in: : PMID: 32973408.
23. Olayemi AB. Assessment and determination of human mandibular and dental arch profiles in subjects with lower third molar impaction in Port Harcourt, Nigeria. Ann Maxillofac Surg. 2011;1:126–130. doi: 10.4103/2231-0746.92775. Cited: in: : PMID: 23482900.
24. Zegan G, Dascalu C, Radu M, Anistoroaei D. Necessity Factors and Predictors of Dental Crowding Treatment. Int J Med Dent. 2015;5:200–206.
25. Goyal S, Goyal S. Pattern Of Dental Malocclusion In Orthodontic Patients In Rwanda: A Retrospective Hospital Based Study. Rwanda Med J. 2014;69:13–18.
26. Bernabé E, Flores-Mir C. Dental morphology and crowding. A multivariate approach. Angle Orthod. 2006;76:20–25.