REVIEW ARTICLE

Human Evolution of the Teeth & Jaws: A Mouthful of History

Hindol Das[1], Vaibhav Motghare[2], Mrinalini Singh[3]

1-Intern, Maitri College of Dentistry & Research Centre, Anjora, Chhattisgarh, India. 2-BDS, MDS, Sr.Lecturer, Department of Public Health Dentistry, Maitri College of Dentistry & Research Centre, Anjora, Chhattisgarh, India. 3-Final Year BDS Student, Maitri College of Dentistry & Research Centre, Anjora, Chhattisgarh, India.

Correspondence to:
Mr. Hindol Das, Intern, Maitri College of Dentistry & Research Centre, Chhattisgarh, India.
Contact Us: www.ijohmr.com

ABSTRACT

The morphology & function of the teeth & jaws of Homo sapiens has changed with hominid evolution to their present form, when compared to those who lived 25,000 years ago, of the last common ancestor of humans & living apes. The field of human evolution is not normally considered within the scope of dentistry, yet the very same jaws & teeth upon which dentistry depends provide much of the essential evidence of human evolution. This review article tells a story of the patterns of dental morphological evolution in the course of time in relation to human origins. It provides a compelling account of how the interaction of diet, speech & environment has shaped human evolution of the jaws & teeth.

KEYWORDS: Evolution, Teeth, Jaws

INTRODUCTION

" Some call it evolution, And others call it God."- Charles Darwin

We hold in our mouth, the legacy of our evolution. Nature has altered living creatures in the course of time, including humans, and so are the teeth & jaws. It has sculpted our teeth over countless generations into tools adapted to perform functions such as mastication & speech. Evolution is best defined as the alteration in the heritable characteristics of biological populations over successive generations. These characteristics are expressions of genes that are passed on from the parent to offspring during reproduction. Teeth connects us to our past. They let us predict our evolution by tracing the changes from one generation to the next. The size, shape, number, location & life expectancy of teeth, as well as the jaws, have constantly changed & evolved to adapt to the functional demands.

The teeth are indeed unique & special: they are essentially ready-made fossils that have remained virtually unchanged for millions of years. They contain the hardest biological substance known (enamel) & durable tissues like dentin that ensures their post-mortem survival long after all other tissues have decayed, and hence they are better preserved as fossils when compared to skulls & bones.[1] Paleontologists & anthropologists spend a lot of time working on them to study human origins & uncover our evolutionary history. It is important to know that much of our knowledge of human evolution comes from dental studies.

Dental tissues contain faithful records of birth & incremental growth, and scholars suggest that molar eruption age, tooth wear, growth disturbances, tooth chemistry, and/or tooth calcification may provide insight into the evolution of human life history.[2] A person's age can be unambiguously calculated from tooth sections, and even forensic science relies extremely upon dental records for identification & evidence.

HISTORY OF HOMINID EVOLUTION OF THE JAWS & TEETH

The word "hominid" refers to the associates of the pedigree of humans, Hominidae; which comprises of every species on our side of the last common ancestors. Morphological changes of the teeth and jaw are significant components of hominid evolution. The evolution of the jaw & the masticatory complex has been related to features that have long been realized as the key trends in human evolution that separate us from our ape cousins & ancestors, such features influencing evolution includes[3]:

- Terrestriality – transformation to living on the ground.
- Bipedalism- having to walk on two feet.
- Encephalization- increase in brain size in relation to the body.
- Development of language & speech.
- Feeding apparatus- change in masticatory apparatus in respect to changing diet.
- The formation of the uniquely human chin.

The human masticatory system consisting of the maxilla, mandible, teeth, temporomandibular joint & the masticatory muscles began to alter with a change in feeding habits, diet & speech. With the modification of the masticatory complex based on environmental changes on our ancestors, Humans became the one most responsive to change & the most versatile of the primate

How to cite this article:
Das H, Motghare V, Singh M. Human Evolution of the Teeth & Jaws: A Mouthful of History. Int J Oral Health Med Res 2018;5(4):32-36.

	Dental formula	Y-5 Cusp Pattern	Cusp Location	Enamel Thickness	Facial Prognathism	Shape of jaws	Chin	Size of Canines
Pan troglodyte	2123	Present	Periphery	Thin	Very Strong	U-Shaped	Absent	Very Large
Sahelanthropus tchadensis	2123	Present	Centrally	Intermediate	Very Strong	U-Shaped	Absent	Large
Orrorin tugenensis	2123	Present	Centrally	Thick	Strong	U-Shaped	Absent	Moderate
Ardipithecus	2123	Present	Centrally	Intermediate	Strong	U-Shaped	Absent	Mild
Australopithecus afarensis	2123	Present	Centrally	Thick	Strong	U-Shaped	Absent	Mild
Paranthropus robustus	2123	Present	Centrally	Very Thick	Moderate	U-Shaped	Absent	Mild
Paranthropus boisei	2123	Present	Centrally	Very Thick	Moderate	U-Shaped	Absent	Mild
Homo habilis	2123	Present	Centrally	Very Thick	Moderate	U-Shaped	Absent	Mild
Homo erectus	2123	Present	Centrally	Very Thick	Mild	U-Shaped	Absent	Mild
Homo ergaster	2123	Present	Centrally	Very Thick	Mild	U-Shaped	Absent	Mild
Homo heidelbergensis	2123	Present	Centrally	Very Thick	Mild	U-Shaped	Absent	Mild
Homo neanderthalensis	2123	Present	Centrally	Very Thick	Mild	U-Shaped	Absent	Mild
Homo sapiens	2123	Present	Centrally	Very Thick	Mild	Parabolic	Present	Mild

Table 1: Dental Morphological Evolution of Our Ancestors

species. Table 1 illustrates various dental morphological evolution of our ancestors.

DISTINGUISHING DENTAL & MAXILLOFACIAL FEATURES OF MODERN DAY HUMANS(HOMO SAPIENS) & EARLY HOMINIDS

The group of early hominids & their orofacial features differed from that of modern-day humans (Homo sapiens). Humans evolved from ape-like ancestors that possessed larger jaws & teeth than our current generation. Evolutionary process has forced the jaw to become smaller along with a reduction in the overall tooth size. Research had shown that this decrease in jaw size, was mostly due to changes in the dietary habits of the species. General patterns of dental morphological changes in humans throughout human evolution are the lack of facial prognathism, a parabolic shaped mandible and maxilla, the presence of a Y5 cusp pattern (the lower molar teeth of apes & humans have five cusps on the occlusal surfaces, this is referred as a Y-5 pattern since it resembles the appearance of the letter 'Y' of the portion between the cusps), the loss of the diastema, and molars that are the same size as the front teeth.[4] In addition, Humans also have small crowns in relation to body mass and tend to show a reduction in cusp and root number. The reduction in the dental architecture was accompanied by molars moving posteriorly and axial inclination of the molar roots.

The theory of evolution proved that humans evolved from chimpanzees.[5] It is hypothesized by the researchers that similar dental morphology existed between the earliest hominid ancestor & chimpanzees today. Hence, major differences can be identified by making comparisons between chimpanzees and Homo sapiens. Figure 1 shows morphological changes in jaws & teeth with evolution & Figure 2 portrays the comparison of Chimp(left), A.afarensis(middle), & Human(right). Characteristic features of evolutionary changes in teeth are as follows:

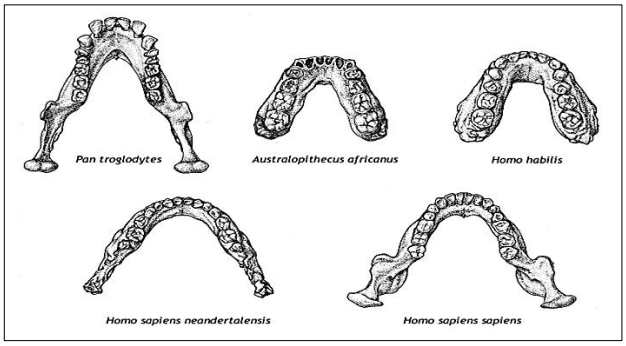

Figure 1: Morphological changes in Jaws & Teeth with Evolution

- **Incisors:** Earliest hominins had larger incisors & were procumbent at the time of the eruption. The decrease in the incisal size in homo sapiens was compensated with the enlargement of premolars & molars.
- **Canines:** Canine teeth of apes were sexually dimorphic when compared to humans. Males had more projected canines than the females. Canines are believed to be small in the earliest hominins. Hominin males generally have small canines. It is reported that the higher the temporomandibular joint, the smaller the canines are in males. The maxillary canines posterior edge was sharpened against the anterior extension of the anterior mandibular premolar in most of the great apes & monkeys.
- **Premolars & Molars:** The extinct hominins had relatively small crowns of the premolars, & the second molar was the largest of the molar teeth & the third molars were closer in size to the second molar. Whereas, in modern humans, the first molar teeth are the largest among the molars & the second premolars contribute more to the tooth row when the first

molar/third molar ratio is high. This is probably due to the larger premolars extending the cheeks anteriorly reducing the size of the mouth. Additionally, the evolutionary shrinkage of the jaw size has left little space for the formation of the third molar, or wisdom tooth.

Figure 2: Comparison of Chimp(left), A.afarensis(middle), & Human(right)

One of the fascinating evolutionary features among Homo sapiens is the presence of a chin.[6] Archaic hominids lacked the protruding chin. Research has shown contradictory views on the function of the chin. While some claimed that the chin acts as a resistance to bending forces on the mandible, others believed that it had no functional importance. Some authors stated that the chin merely emerged as a point after the shortening of the mandible. Scientists also claim that shortening of the dental arch left the chin as a protrusion in the mandible. Ichim et al. have also asserted that the formation of chin might have been due to the repetitive contractions of the tongue & the perioral musculature. Various biomechanical studies have shown that chinned & nonchinned mandible resisted the same masticatory bending forces.

The occlusal plane in humans is not truly horizontal & is helicoidal. A helicoidal occlusal plane in an inclination of the teeth where the anterior buccal teeth show a plane sloping upward palatally while the more posterior teeth have a plane sloping upward buccally forming a twisted occlusal plane. A helicoidal occlusal plane could possibly be considered as a functional adaptation in itself. This developed the curve of spee which is more pronounced in humans compared to other hominids.

With evolutionary changes in the jaws & teeth, distinct changes have been reported in the position of the temporomandibular joint. The temporomandibular joint is high in the hominoids. In Homo sapiens, the temporomandibular joint has moved forward. These changes were probably related to modifications of food processing & diet.

EVOLUTION OF THE JAWS & TEETH WITH DEVELOPMENT OF SPEECH

In the history of the evolution of life, humans are the only species that can talk & speak words, and only because of the amazing features of the jaws & teeth. Humans define words & its oropharyngeal system differed from other mammals for having communication as a dominant function. Speech & language enabled Homo sapiens to harmonize their activities for providing food and increase the foraging ability of our species. Development of speech is believed to be one of the most important changes in human evolution.

Speech & language need a flexible oral system. The flexibility of the orofacial musculature is obtained by providing processed as well as softened food, which does not demand a strong musculoskeletal build & sharp teeth. Speech is produced by the coordination in the functions oropharynx, tongue, teeth & lips. The anatomical evolutionary changes required for speaking results in pharyngeal collapse. However, development of obstructive sleep apnea is prone to such changes. According to Davidson, the supralaryngeal vocal cord tract (SVT) has been altered to form a 1:1 ratio between the horizontal & vertical segments.[7] The shortening of the midface has facilitated a decrease in the horizontal dimension of the SVT & the descent of the larynx produced lengthening of the vertical SVT. Displacement of the tongue from the oral cavity into the pharynx along with a narrowed, elongated distensible pharynx & cranial base angulation enabled humans to speak, talk & communicate with complex language. The shortening of the mandible & reduced size of the palate with evolution also facilitates the required physiology necessary for speech.

With evolution, the brain has become larger (encephalization) while the jaws & teeth have become smaller & the bipedal posture required a smaller mouth for synchronization of the center of gravity of human cranium. As the jaw evolved, decreased pressure on the cranial sutures was evident with weakening of the muscles. The overall changes in the maxillofacial system have led to the ability of humans to speak. Figure 3 depicts the encephalization of brain in relation to jaws & teeth with human evolution.

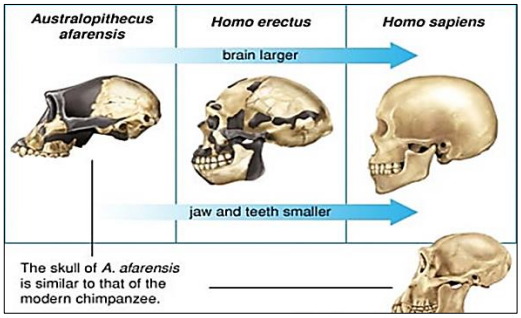

Figure 3: Encephalization in relation to size of jaws & teeth with human evolution

EVOLUTION OF THE JAWS & TEETH WITH TRANSITION IN DIET

Jaws & teeth are the keys to unlocking the diets of our ancestors. There is a common correlation between teeth,

diet & human origins. The evolution course of the jaws & teeth has been influenced by the foods eaten & the processing of foods by fire & tools. A transition from a coarse abrasive diet to a soft diet was observed with evolution, as primitive man learned to break up his food with his hands. According to Darwin, it was believed that soft diets are the most significant aetiology for decreased jaw growth in modern humans.

The change in diet pattern has led to smaller, less prominent jaws with small teeth & non-projected canines together with a smaller face in Homo sapiens.[8] As humans learned to soften his foods by cooking, it decreased the need for carnivore adaptations of the jaws & teeth. The ancient diet of humans tended to be extremely abrasive which caused attrition of the teeth, & needed strong bones (jaws), large canines & stronger muscles of mastication, unlike modern humans.

VESTIGIALITY & AGENESIS OF WISDOM TEETH WITH EVOLUTION

The wisdom teeth (third molars) are believed to be vestiges of human evolution. Vestigiality is described as the remaining part during the evolutionary process of genetically determined structures (e.g. third molars) that is imperfectly developed & have lost some or all of their ancestral function. Nature tries to eliminate that which is not used, similarly evolution has eliminated the masticatory demand for large, powerful jaws & reduced the size of our maxilla & mandible. The third molars are considered as a vestigial organ without any purpose or function. According to the phylogenic theory, it is truly believed that the jaws decreased in size from a lack of function. Our ancestors had larger jaws to combat with the functional demands of hard, coarse, unprocessed & uncooked foods that required more chewing power; so there was room for 32 permanent teeth including the wisdom teeth(third molars). But now, there's no longer room in most of our oral cavity to house 32 teeth since our jaws have become smaller. Therefore, the last teeth we develop (wisdom teeth/third molars) is often impacted or blocked from erupting. As a result, dentists choose to remove them through surgery.

It is believed that evolution will make our wisdom teeth disappear. The wisdom teeth generally erupt at the age between 17 to 25 years, and it is the last teeth to erupt in the oral cavity. However, nowadays the prevalence of individuals not developing third molars has increased and are common cases of modern human evolution, and is referred to as "M3 agenesis". This case is when the third molars or wisdom teeth failed to form & appear in individuals. Agenesis of third molars is not the same as impaction where it fails to erupt normally or remains within the jaw. According to studies conducted by Carter & Worthington (2015), M3 agenesis is highest in Asian populations today, & lowest in Africans.[9] Single missing third molar is the most frequent M3 agenesis followed by missing two molars. It is very rare to be missing three or all four of the third molars. The studies have shown that females are more likely to be missing an M3 than males. M3 agenesis is a fascinating example of biological transition in humans with evolution.

CROWDING OF TEETH WITH EVOLUTION

Our ancestors very rarely had malocclusions due to dental crowding when compared to modern day humans where crowding of the dentition & resulting malocclusion is very common. Dental crowding is endemic among technologically advanced populations, and the most significant reason in the development of most dental crowding is the lack of dental attrition. Studies have shown that the dietary shift to soft, processed foods in modern humans cause little or no attrition of teeth. However our ancestors had a coarse, hard gritty, fibrous & unprocessed diet that caused both interproximal & occlusal attrition of the teeth. Attrition produces mesial drift[10] (All teeth move gradually forward towards the front of the mouth) where the space required to accommodate the teeth in each jaw gradually becomes less, allowing proper arrangement of the teeth with no evidence of dental crowding.

Modern homo sapiens have hardly any attrition of the teeth. Hence, it results in dental crowding since they do not require large chewing forces that lead to lateral movement of the teeth & interproximal wear. However, low incidences of crowding in primitive populations were due to the high degree of interproximal attrition & lateral movement of the teeth since our ancestors required high chewing forces. Figure 4 represent the evolution of the maxillofacial complex.

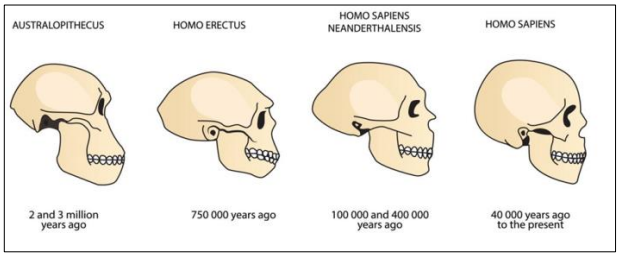

Figure 4: Evolution of the maxillofacial complex

CONCLUSION

Our teeth reflect our evolutionary history, & they have constantly evolved from our ancestors to the present day. We brush them every day, flash smiles, chomp through our meals, yet we forget the amazing role teeth play in the story of human evolution. The development of speech, alterations in diet, the disappearance of wisdom teeth & dental crowding with evolution have all influenced the morphology of the jaws & teeth way beyond the knowledge of the dentists.

REFERENCES

1. Lucas, PW, Peters CR. Development, Function and Evolution of Teeth pp.282–289.. Teaford M F, Smith M M, Ferguson M W J, eds. Cambridge, U.K, Cambridge Univ. Press; 2000.
2. Leonard, WR, Robertson ML. Nutritional requirements and Human Evolution: a bioenergetics model. Am J Hum Biol. 1992; 4: 179-195.
3. Teaford, MF, Ungar PS. Diet and the evolution of the earliest human ancestors. Proc Natl Acad Sci U S A 2000; 97:13506- 11.
4. Hunt, K, Vitzthum VJ. Dental metric assessment of the omo fossils: implications for the phylogenetic position of Australopithecus africanus. Am J Phys Anthropol 1986; 71: 141-55.
5. Diamond, J. The third Chimpanzee: the evolution and future of the human animal. New York: HarperCollins Publishers; 1992: p. 21, 23, 32–54, 54–6.
6. Schwartz, JH, Tattersall I. The human chin revisited: what is it and who has it? J Hum Evol 2000; 38: 367–409.
7. Lieberman, P. "Human speech and language." In: The Cambridge Encyclopedia of Human Evolution, Cambridge University Press, 1992: pp. 134-137.
8. Milton, K. "Primate diets and gut morphology: implications for hominid evolution." In Harris M, Ross EB (eds): Food and Evolution: Toward a Theory of Food Habits, pp. 93-115. Philadelphia, Temple University Press.1987.
9. Ebbert, S. and Sangiorgio, M., 1991. Facing the dreaded third molar. Prevention, 43(7): 108-110.
10. Southard, T.E., 1992. Third molars and incisor crowding: when removal is unwarranted. Journal of the American Dental Association, 123(8):75-78.

Source of Support: Nil
Conflict of Interest: Nil