

The Advent of Agriculture and the Corresponding Effect on the Human Masticatory Complex

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Abstract

In prehistoric era, humans solely depended on foraging and hunting for their existence. The food that they ate was tough and it required a lot of masticatory force for chewing. The result was that prehistoric humans possessed more robust crania and jaws. Their teeth showed signs of wear due to the heavy masticatory forces.

Later, certain groups of humans began to domesticate plants for food thereby giving rise to the agricultural era. Thus, humans began to rely on softer and more refined food. This shift in the nature of the diet had a profound impact on the cranial, jaw and dental architecture. The newer, softer food required lesser masticatory forces for chewing. Consequently, stresses to the crania, jaws and teeth were reduced which led to a corresponding change in their respective forms. This article highlights the changes induced in the human masticatory complex as a result of the advent of agriculture in the history of mankind.

Introduction

Around ten thousand years ago, certain human groups began to depend on diets derived from domesticated plants and animals rather than acquiring wild sources of food via hunting and foraging. This change in diet occurred independently in several global regions, with particular starchy crops (example: wheat, barley, rice, maize).¹

Agricultural diets are generally less variable, higher in starch and sugars and lower in protein compared with forager diets. Agricultural diets are also softer on average than forager diets, meaning that they are mechanically less demanding in terms of chewing.¹

Softer agricultural food reduces the masticatory demand, resulting in less robust craniofacial skeletons, reduced and repositioned masticatory muscles.² Several studies comparing hunter-gatherer and farming populations in Nubia, Ohio Valley and Southern Levant have supported

the associated change between the masticatory apparatus and the initial transition to agriculture.³

Why Cranial, Jaw And Dental Reductions Occurred In Humans?

This has indeed been an intriguing question and it is well answered by the following models that have been proposed by researchers to explain reduction trends in the crania, jaws and dentitions of humans:

- The Probable Mutation Effect (PME).
- Increasing Population Density Effect (IPDE).
- Selective Compromise Effect (SCE).

The Probable Mutation Effect (PME)

This model suggests that in the absence of natural selection, mutations will be the main force acting towards the reduction of structural size and complexity of teeth and other organs. Therefore, developmental processes, controlled by complex genetic mechanisms will be disrupted resulting in an incomplete or a simplified dental structure.

Brace and Mahler hypothesized that the invention and use of pottery by humans and the subsequent changes in food preparation techniques led to a relaxation of selective forces on the masticatory apparatus and the onset of PME which resulted in a consequent decrease in tooth size.

Increasing Population Density Effect (IPDE)

This model suggests that reduction in dental crown size occurred due to changes in population densities associated with the transition to a sedentary lifestyle due to the advent of agriculture. This triggered a selection for reduction in nutritional and metabolic requirements, which led to a corresponding decrease in body size. Reduction in tooth size was therefore a byproduct of selection for smaller body size.

Selective Compromise Effect

This model proposes that larger morphologically complex crowns provide more surface area for caries, which in turn

can significantly affect the individual's fitness. However, large crowns are essential for the mastication of abrasive foodstuff. In the case of populations that are undergoing a subsistence shift following the transition of agricultural economy, a selective compromise must occur between a selection for smaller teeth with less complex cusp pattern and thin enamel and a selection for bigger teeth with thicker enamel to counter occlusal wear. A central aspect of this model is the assumption that selection for smaller dentition is triggered by dental crowding and high prevalence of cariogenic disease.

How Were The Dental Features Of Prehistoric Hunter-Gatherer Communities?

Prehistoric hunter-gatherer communities with extensive wear of teeth due to a rough diet before the advent of agriculture showed the following features in their dentition:⁴

- Flatly worn occlusal surfaces of teeth.
- Development of a reversed Monson curve in posterior teeth (occlusal plane that inclines downward to buccal).
- Extensive interproximal wear.
- Anterior edge to edge occlusion.
- More upright positioning of anterior teeth and a nearly flat occlusal plane in lateral view.

The following diagram illustrates the formation of an edge to edge bite of the incisors in prehistoric hunter-gatherer populations as a result of chewing hard and tough food:



Reduction In The Dentition And Masticatory Apparatus In Nubia

The work of Carlson and Van Gerven indicated that a progressive decrease in the size and robusticity of the mandible and masticatory apparatus was the dominant feature in the transition from the Mesolithic period to the Agriculturalist period in Nubia. Masseter origin length displayed the greatest dimensional change, experiencing a dramatic 21.6% reduction between the Mesolithic period and Agriculturalist period. The variables pertaining to relative height of the cranial vault and face increased, resulting in a change in craniofacial shape to a more globular form and a less robust craniofacial appearance. These changes occurred due to a decrease in masticatory functional demands related to a dietary shift.⁵

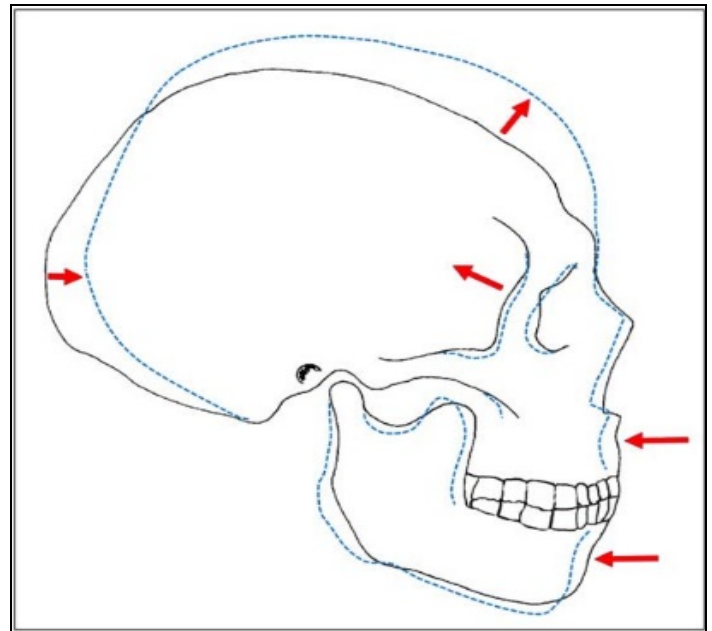
Mesolithic Nubia was characterized by intensive gathering and hunting whereas the Agriculturalist period exhibited more dependency upon the cultivation of barley, millets and sorghum along with some herding. Based on the decreased robusticity of the masticatory apparatus, Carlson and Van Gerven predicted a reduction in the size of the teeth and associated alveolar region due to the reduced anteroposterior growth of the maxillo-mandibular complex.⁵

Virtually every mandibular length, breadth and height measurement decreased significantly from the Mesolithic period to the Agriculturalist period in both sexes, including height and breadth of the corpus and ascending ramus, the breadth of the mandible and the maximum length of the mandible.⁵

All teeth decreased markedly in size from the Mesolithic period to the Agriculturalist period in accordance with reduction in jaw size.⁵

The following diagram illustrates the change in the dentition and masticatory apparatus in Nubia from the

Mesolithic period to the Agriculturalist period. The red arrows indicate the direction of growth in the crania and jaws after the advent of agriculture as a result of eating soft food. The black line indicates the position of the crania and jaws in the hunter-gatherers. The blue dotted line indicates the position of the crania and jaws in the agriculturalists:



Evolutionary Changes In The Masticatory Complex Following The Transition To Farming In The Southern Levant

The Levant is the region in which some of the world's earliest farming communities first emerged. The transition between foraging and food production economies in the Levant was a major threshold in human prehistory.⁶

Pinhasi et al analyzed the masticatory apparatus of late hunter-gatherers and early farmers from the Southern Levant region. The study results indicated a pronounced reduction trend that mainly affected the buccolingual dimensions of the upper and lower dentition. However, the reduction in the buccolingual dimensions of the lower dentition was not accompanied by a corresponding reduction in the overall dimensions of the mandible. Only

the anterior symphyseal height and the ramus breadth were significantly reduced over time. Overall decrease in the crown area was reported, however, overall decrease in the dental arch length was not observed.⁶

Size And Morphology Of The Permanent Dentition In Prehistoric Ohio Valley Amerindians

Paul W. Sciulli studied tooth samples of prehistoric Amerindians from three burial complexes situated in the Ohio Valley. The names of the locations of the burial sites are as follows:⁷

- Glacial Kame
- Adena
- Ohio Hopewell

Paul W. Sciulli compared the tooth size of the prehistoric Amerindians from the Ohio Valley burial complexes with that of the Late Archaic Indian Knoll Amerindians. The study showed that there was an overall decrease in the size of the teeth of the prehistoric Amerindian communities that resided in the Ohio Valley. The reduction in the tooth size was attributed to a shift from a hunter-gatherer lifestyle to that of a farming society in the prehistoric Ohio Valley communities.⁷

Conclusion

Hence, to conclude, it is clear that prehistoric hunter-gatherer communities had an overall robust craniofacial skeleton, large jaws and teeth which exhibited wear. This was due to the heavy masticatory forces required to chew the hard and tough food. On the other hand, agriculturalists have a delicate and gracile craniofacial skeleton, since the diet is softer and more refined. Agriculturalists have smaller jaws in comparison to prehistoric hunter-gatherers and their dentition does not show signs of wear.

Thus, the advent of agriculture in the history of mankind has played a role in changing the masticatory complex of humans.

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