Wisdom Can Be Painful: Third Molar Impaction In Human Populations and Its Evolutionary Significance

Since Charles Darwin published *the Origin of Species* in 1859, evolution and the mechanisms underlying evolutionary change (or descent with modification) have been variously characterized. Initially, the notion of survival of the fittest was employed by Darwin to describe natural selection (see Chapter 4 of the *Origin*). This concept, which Darwin borrowed from Herbert Spencer, has been, and continues to be used to this day by some to describe Darwinian evolution. It is not an accurate, or even suitable concept for natural selection and it has been replaced in most discussions by the term "reproduction of the fittest" or differential reproduction. I want to emphasize this because my discussions of the evolution of human third molar biology very much hinges on how we view evolution. A deleterious variation may not prove fatal to the carrier but would, instead, influence the number of offspring that are conceived, born and reach reproductive maturity. Evolution acts to produce function not perfection; this is the reality of how life has developed.

It would appear reasonable that some of the changes in the evolution of the human dentition are the result not of specific selective forces on the teeth themselves, but rather evolution

operating on other biological complexes. As selection brings about modification in one complex, other, associated, biological systems also undergo modification to maintain function. From about 2 million years ago, evolution appears to have been selecting for increasing brain size. From earlier hominins of the australopithecine grade, with brain volumes of about 375-500cc, early members of *Homo* possessed brains from about 650-1000cc. Later members of this genus, *Homo erectus* and early *Homo sapiens* (this includes, for me, "Homo heidelbergensis") possessed brain volumes within the range of living humans, whose brain sizes can reach 1600cc. The selective pressures underlying this evolutionary expansion remain unclear, with tool making, complex social behavior and cooperation, use of a larger number of seasonally diverse habitats and increasingly long childhoods, especially with the origins of 'Middle Childhood' all being suggested. It may be that all of these factors played a role.

This dramatic expansion in brain size modified the shape and dimensions of the braincase, in particular, broadening skull width and widening the distance between the mandibular condylar articulations with the braincase base. This architectural reconfiguration of the skull, along with the expansion of the brain's frontal and prefrontal lobes (which overlie the face), resulted in the repositioning of the face more underneath the

base of the braincase. The facial complex maintained function with a widening and a relative shortening of the dental arcade. Earlier hominins, like the australopithecines, possessed very large posterior teeth, the premolars and molars, housed in jaws that were relatively long, jutting out in front of the braincase. Later evolution resulted in a widening of the dental arcade and consequent shortening of the face. The result of these changes in living humans has been a shortened and parabolic dental arcade; it is no longer large enough to house the complete adult dentition, 32 teeth, 16 in each jaw, an evolutionary retention from our higher primate ancestors. As a result, in many adolescent humans, the last tooth to erupt in human dental development, the third molar (the perhaps misnamed 'wisdom tooth'), cannot erupt normally into its occlusal position with opposing teeth but ends up either out of occlusion or impacted, unerupted, often lying horizontally and in contact with the second molar in front of it or with the soft tissues around it. This condition can lead to chronic pain and to reduced reproductive fitness, but not generally death. Some thousands of years ago, a genetic change, or changes, brought about the suppression, or agenesis, of the calcification of the third molar. Recent research has isolated a number of clustered and unclustered Hox and Homeobox genes where minor changes,

often SNPs, result in the agenesis of one or more of the teeth. Often, these mutations also result in other developmental or biological changes, such as early onset of cancer and malformation of cranial and postcranial bones. However, the precise mutation, or mutations, that may have been responsible for the loss of the third molar have not, as yet, been identified but it seems likely that this variation was not accompanied by associated dental, osteological or health related changes. Because it reduced the incidence of third molar malocclusions and impactions, there was positive selection for this variation and the frequency of third molar agenesis has increased, with 25% of individuals in many human populations lacking at least one third molar. European populations have an incidence of at least one missing third molar of between 10-15% with 80% of those effected involving one or two teeth only. The frequency of agenesis of other teeth ranges from 1.6-9.6%, with the maxillary second premolar (P^4)and mainly the lateral incisor (I^2) being the teeth primarily missing. Deciduous teeth are much less likely to be agenetic, with a frequency of .5-.9%; if a deciduous tooth is agenetic, the successional permanent tooth is also likely to be missing.

The agenesis of third molars has not been the only consequence of the decreased size of the dental arcade. Over the

course of hominin evolution, the posterior teeth, the premolars and molars, have undergone significant reduction in size. The anterior teeth, while also becoming smaller, have not reduced in size to the same extent. There are also other changes that are noteworthy. Early hominins possessed second lower molars that were typically hominoid in cusp organization with five cusps arranged on the chewing surface. Modern humans and some earlier hominins have lost the most posterior cusp (hypoconulid), which has significantly shortened the length of this tooth. Similarly, both the upper and lower third molars, when they are present, have lost cusps, which has resulted in their reduction in length.

One pertinent question is to understand how differential reproduction might have acted to increase the frequency of third molar agenesis. One plausible scenario might be as follows: One evening, a partner in a relationship suggests a bout of reproduction. The other partner, plagued by an impacted third molar which is painful enough to be distracting, says: “not tonight dear, my jaw is killing me”. The limiting of reproductive behavior limits the number of offspring and thus, over generations, people who do not have this particular distraction, will have a slighter greater number of children; the frequency of third molar agenesis will increase. However,

with the development of medical intervention in the developed world, the positive selective value of agenesis has been reduced but it remains a ‘scar of human evolution’ in much of the developing world.