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Erosion and tooth wear: An anthropological perspective

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Introduction

Anthropological research of many pre-contemporary hunter-gatherer populations (eg. Australian Aboriginal) has attributed tooth wear to be a normal physiological process that results from function. The most common functional activity is the mastication of food, where the abrasiveness of the diet is largely responsible for the extent and pattern of wear observed (Kaifu 2003). In addition, the use of teeth as tools was a common activity that contributed to the wear (Molnar 1972). Furthermore, anthropologists have argued that as teeth wear, they not only remain functional throughout life, but the whole stomatognathic system changes or adapts as a consequence to the wear indicating a dynamic craniofacial complex (Kaifu et al. 2003, Richards 1985). This anthropological approach is in contrast to the premise that the newly erupted tooth is the most ideal functional form.

During this dynamic process, as the cusps reduce in height, the "teardrop" masticatory pattern becomes wider (Barrett 1977) with an associated "remodelling" of the glenoid fossa (Richards 1984), and the teeth physiologically continually erupt as a compensatory mechanism to wear. The interplay between the rate of wear and continual eruption determines the occlusal vertical dimension. This change in tooth form is described in modern dentistry as a continuum from canine rise, to group function, to a flat occlusal plane with an edge-to-edge anterior bite.

Furthermore, there is also a direct relationship between the occlusal load (produced during vigorous mastication), interproximal wear and the reduction in arch length resulting from the mesial migration of teeth (Fig. 1).

Fig. 1: Excessive abrasion and interproximal wear on the deciduous first and second molars of a pre-contemporary Australian Aboriginal child.

Zoom

Anthropologists have argued that this reduction in arch length is partly responsible for third molar eruption without impaction as seen in Aboriginal skeletal material (Begg 1954). Interestingly, contemporary Aboriginals show the same level of third molar impaction as do white populations, reflecting the relatively lower rates of wear resulting from the consumption of softer, processed food.

Although, anthropologists in the past century have used the terms attrition, abrasion and even erosion synonymously as general terms to describe the abrasive effects of food, in reality these terms are different and distinct mechanisms that dental researchers have more recently defined. Attrition and abrasion result from mechanical action on tooth surfaces, while erosion is a chemical interaction. The perplexing question is, where does erosion sit within the overall paradigm?

The mechanisms of wear in perspective

Attrition occurs from tooth-to-tooth contact without the presence of food (ie. tooth grinding) and is characterised by the facet (Fig. 2) that is usually a flat area with a well demarcated border (Every 1972).

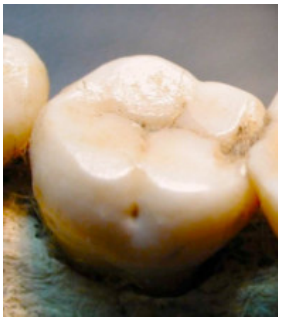


Fig. 2: Facets with demarcated borders on the lower right second molar of a pre-contemporary Australian Aboriginal.

Zoom

Every facet has a matching facet in a tooth in the opposing arch and when dentine is exposed it wears flat without scooping (Kaidonis 2007). The prevalence of attrition varies extensively within the literature. In general, those that report low levels are often based on

questionaires that are subjective, however studies based on the frequency of faceting show a very common behaviour. Reports on the frequency of faceting from skeletal material of pre-contemporary aboriginal populations (Kaidonis et al. 1993) together with non-aboriginal patients randomly attending a general dental practice in South Australia (Kaidonis 2007) both show a prevalence of over 90%. Interestingly, comparative studies of extinct and extant species also show facets to be a common observation.

Abrasion occurs when exogenous material (ie. foreign to the body) gets forced over tooth surfaces (Every 1972). Exogenous material not only includes food but other foreign bodies (eg. tooth picks, tooth brush, pipe stems etc) and all produce characteristic patterns of wear on the dentition. In contrast to the well defined facet, the mastication of food produces an abrasion area that is not "anatomically specific", where the food depending on its consistency can act anywhere on the occlusal and incisal surfaces until the softer dentine scoops upon exposure (Fig. 3) .

Zoom

Fig. 3: Evidence of extreme abrasion and dentinal scouping of the dentition of a pre-contemporary Aboriginal.

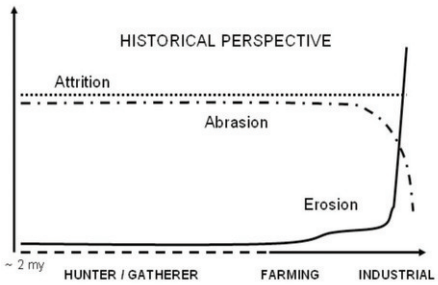
Scooped dentine is not sensitive because the mechanical action produces a smear layer that closes dentinal tubules, and interestingly the depth of the scoop relative to the surrounding enamel remains fairly shallow yet constant depending on the type of diet (Bell et al. 1998).

It can be argued that mechanical wear has existed ever since teeth first evolved, and is the main selective force that has influenced the evolution of teeth in nearly all species. Teeth have evolved ways to compensate for wear (eg. continual eruption), while the physiological properties and anatomical relationship of enamel and dentine provides for the efficient processing of food when teeth are worn. How this occurs is not the purpose of this manuscript, however, the exposed enamel ridges resulting from the scooping of dentine have a functional purpose (Smith 1959, Every 1972, Kaidonis 1992) and have been documented in many different species, especially herbivores. That is, as wear progresses, functionality is maintained.

Erosion occurs from the dissolution of tooth tissue (ie. acid) without he presence of plaque (Yip et al. 2006). Although acids do produce various erosive patterns depending on their source (ie. intrinsic or extrinsic), the effected area when active normally appears glazed with

loss of micro-anatomical features. As with abrasion, dentine will also scoop when exposed. However, scooped dentine from acid is often sensitive due to open dentinal tubules and the dentine will continue scooping and become quite deep in the presence of acid.

In contrast to mechanical wear, erosion seems to be a modern-day disease. To date there has been no evidence of erosion in skeletal remains of hunter-gatherer societies such as Australian aboriginal, ancient American skulls and historic and prehistoric European populations (Aubry et al. 2003, Aaron 2004).Water would have been the most common liquid consumed among hunter-gatherers. Exposure to acids from dietary sources most definitely would have occurred, however such exposure would have been seasonal and therefore transient. In addition, the natural remineralising protective effects of saliva, together with the physical presence of biofilms on the tooth surface, would have made the effects of acids insignificant. Human populations gradually had an increasing exposure to acids with the advent of farming and especially through the middle ages where food fermentation techniques were developed. However, is not until we reach today's modern society where exposure to acids have reached very high proportions resulting in an imbalance to the to the oral environment (Fig. 4).



Zoom

Fig. 4: A general diagrammatic representation of the three mechanisms of wear from a historical perspective. Attrition seems to be as prevalent now-days as in earlier populations, while abrasion is by far reduced in more affluent societies due to processed foods. Erosion, though insignificant in the past, has become a major problem in today's population.

Furthermore, the non-carious cervical lesion commonly described in the literature, to date, have not been reported in early human populations. Recent evidence indicates that the formation of such lesions relates to a combination of erosion and toothbrush abrasion (Nguyen et al. 2008) again supporting the model that erosion was not of significance in ancient populations (Fig. 5).

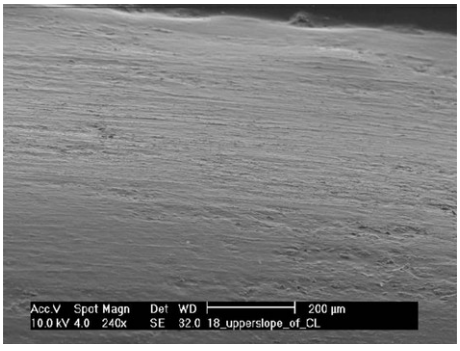


Fig. 5: Scanning electron micrograph of the dentinal surface of a wedge shaped lesion from a patient. The horizontal scratch marks are evidence of mechanical action.

Zoom

In addition, the heavy occlusal loads associated with the extensive abrasive wear documented in such hunter-gatherer societies, questions the concept of abfraction that proposes that the wedge-shaped non-carious cervical lesions results from the flexion of teeth under load.

The interaction between the mechanisms of wear will vary between populations and individuals. The interplay between attrition and abrasion has been reported in desert dwelling Australian Aboriginal populations (Kaidonis 1992), and although current affluent societies consume softer, more processed and therefore less abrasive food, the interplay is now commonly between attrition and erosion. However, clinicians must be aware that even mild abrasion in an erosive environment can accentuate the overall wear. Therefore the term "erosive wear", highlighting erosion with superimposed mechanical abrasion is appropriate.

Physiological v/s pathological wear

Although, tooth wear from mechanical action has been described as a physiological process, there are times when the clinician is faced with a pathological oral condition. From a clinical perspective, operative intervention is a subjective decision based on whether the observed wear, when compared to age is physiological or pathological (Richards 2003). Although there is strong anthropological evidence to suggest that even though extensively worn teeth from mechanical action can remain functional throughout life, often premature operative intervention occurs for aesthetic reasons. It can be argued that this action can be considered as legitimate if it were a patient's request. Aesthetics varies across cultures and period, and is essential in this day and age, even though it is strongly influenced by today's "magazine smile".

There is a case for the longitudinal monitoring of the wear activity of patients (Kaidonis 2007) who present with physiological wear. However it must be reaffirmed that although very mild yet active erosion may be correctly approached from a preventive, non-operative perspective, this does not make the erosive effect on teeth physiologic.

Conclusion

Mechanical action has affected the teeth of human populations living as hunter-gatherers, long before the advent of farming and the present. During that evolutionary timescale human teeth (as with other species) have evolved ways of taking advantage of the wear or compensating for it while still remaining functional. In addition, the craniofacial structures change accordingly to this functional load. In contrast, although teeth have also been exposed to dietary acids for millennia, the protective effects of the oral environment has made erosion in past populations rare and therefore insignificant. However, the frequent exposure to strong acids within our modern cultures has overwhelmed our oral

environment, tipping the balance towards the pathologic breakdown of teeth.

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