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NEW EVIDENCE AND INTERPRETATION OF SUBVERTICAL GROOVES IN NEANDERTAL TEETH FROM CUEVA DE SIDRÓN (SPAIN) AND FIGUEIRA BRAVA (PORTUGAL)

ABSTRACT: Interproximal tooth wear is caused by tooth-to-tooth rubbing that results in the formation of flat wear surfaces characterized by an intense pattern of enamel pitting caused by prism-plucking. The rate of wear of such surfaces depends on the forces involved in food processing and chewing. In some instances, the interproximal wear facets, mainly of molar teeth, show a number of subvertical grooves with a nearly vertical direction. These grooves are mostly present in Neanderthal teeth, but have also been described in some African fossil teeth and in European Homo heidelbergensis, *as well as in several modern hunter-gatherer populations, such as Australian Aborigines. Subvertical grooves have seldom been attributed to taphonomic processes, although most probably they are caused by natural biomechanical processes during mastication of hard objects included in the diet. They have also been associated to acidic dietary habits given their radial disposition and their inter-digitalisation. The present study analyses the subvertical grooves observed in the Neanderthal dentition of Cueva de Sidrón (Spain). Comparisons are made with the similar interproximal grooves pattern observed in the Neanderthal specimen from Figueira Brava (Portugal) and some remains of* H. heidelbergensis *from Sima de los Huesos (Spain). Other cases have been described for the Neanderthal sites of Genay and Le Fate (France). The results obtained allow discarding a* post-mortem *origin of these structures, the most probable cause of the subvertical grooves being natural biomechanical chewing processes combined with some dietary habits indicative of hard plant foods ingestion.*

KEYWORDS: Subvertical grooves – Interproximal facets – Teeth – Neanderthals

INTRODUCTION

Subvertical grooves consist of large furrows that can be observed on the interproximal wear facets of some teeth, generally molars, of certain human populations. They show a characteristic morphology, running in a occlusal-to-cervical direction, with a generally radial disposition close to the occlusal side of the tooth crown. The number, length and width of the subvertical grooves greatly vary both within and between populations. They have been described in a number of Neandertal specimens, such as Figueira Brava in Portugal (Antunes, Santinho 1992), Caverna delle Fate in Italy (Giacobini *et al.* 1984, Villa, Giacobini 1995), Fondo Cattie in Italy (Borgognini-Tarli 1982), and Genay in France (De Lumley 1987). Some fossil specimens from Africa have been shown to have subvertical grooves, as is the case of *Homo habilis* from Omo in Ethiopia (Puech, Cianfarani 1988) and *Homo sapiens* from Qafzeh in Israel (Vandermeersch 1981). In the modern human Australian Aborigine populations subvertical grooves have appeared in 60% of the individuals analysed, whereas in white Australians the frequency was about 30% (Kaidonis *et al.* 1992).

FIGURE 1. SDR-015 lower, right M2 tooth of the Neandertal from Cueva de Sidrón (Asturias).

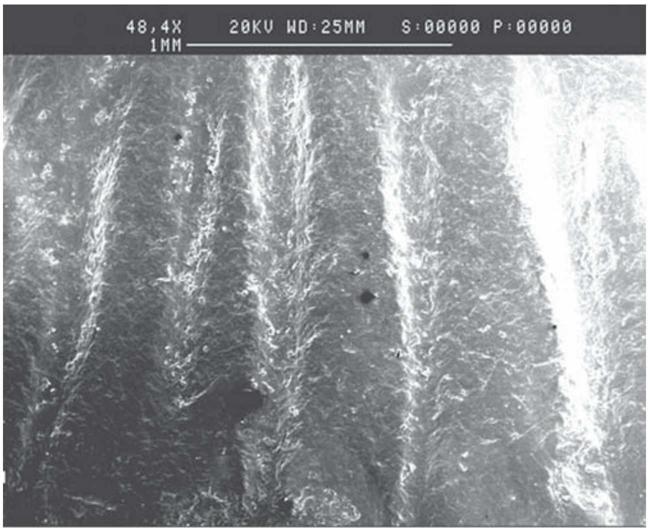

FIGURE 2. Interproximal grooves on the distal facet of SDR-015.

FIGURE 3. Upper, left P4 of the Neanderthal from Figueira Brava (Portugal).

Although some researchers have attributed the presence of subvertical grooves to post-depositional processes (Antunes, Santinho 1992), it is reasonable to think that *ante-mortem* processes of dental abrasion are responsible for their formation. The presence of subvertical grooves on the interproximal wear facets could be related to the consumption of hard food materials inducing a high masticatory stress (Wolpoff 1971, Osborn, Ten Cate 1983). The effect of acidic fluids between the interproximal teeth spaces during mastication could have contributed to their formation (Ramfjord, Ash 1966, Villa, Giacobini 1995), along with structural constraints of the enamel in the areas of teeth contact (Rensberger 1978). The higher presence of these grooves in Neanderthals could be the result of the interaction among a particular diet composition, specific dietary related habits, and higher masticatory forces involved in food chewing and processing.

MATERIAL AND METHODS

Subvertical grooves have been observed in several teeth in the course of a tooth microwear research for dietary interpretation of fossil humans. Previously non-described grooves were observed in one Neanderthal specimen SDR-015 from Cueva de Sidrón (Piloña, Asturias), a lower, right M2 (*Figure 1*) curated at the Dept. Biología de Organismos y Sistemas (BOS) of the University of Oviedo. The Neanderthal remains from this site have been extensively described (Egocheaga *et al.* 2000, Rodríguez, Egocheaga 2000, Rosas, Aguirre 1999). The analysed tooth shows an intense pattern of subvertical grooves (*Figure 2*) that greatly resembles that of the upper, left Pm4 Neanderthal specimen from Figueira Brava (*Figures 3, 4*) in Portugal (Antunes, Santinho 1992). In both cases the grooves are very well marked and deep, with a clear radial disposition from the occlusal plane. Subvertical grooves have been observed also in some *H. heidelbergensis* teeth from Sima de los Huesos (*Figure 5*), but they tend to show a reduced number and less profound grooves.

All subvertical grooves on the interproximal wear facets were observed on tooth crown moulds made with *PresidentJet Microsystems*, Regular Body polyvinyl (Coltène) for the negative cast, and *EpoTk-301* (QdA) resin for the positive mould. Scanning Electron Microscopy (SEM) micrographs were obtained at different magnification levels.

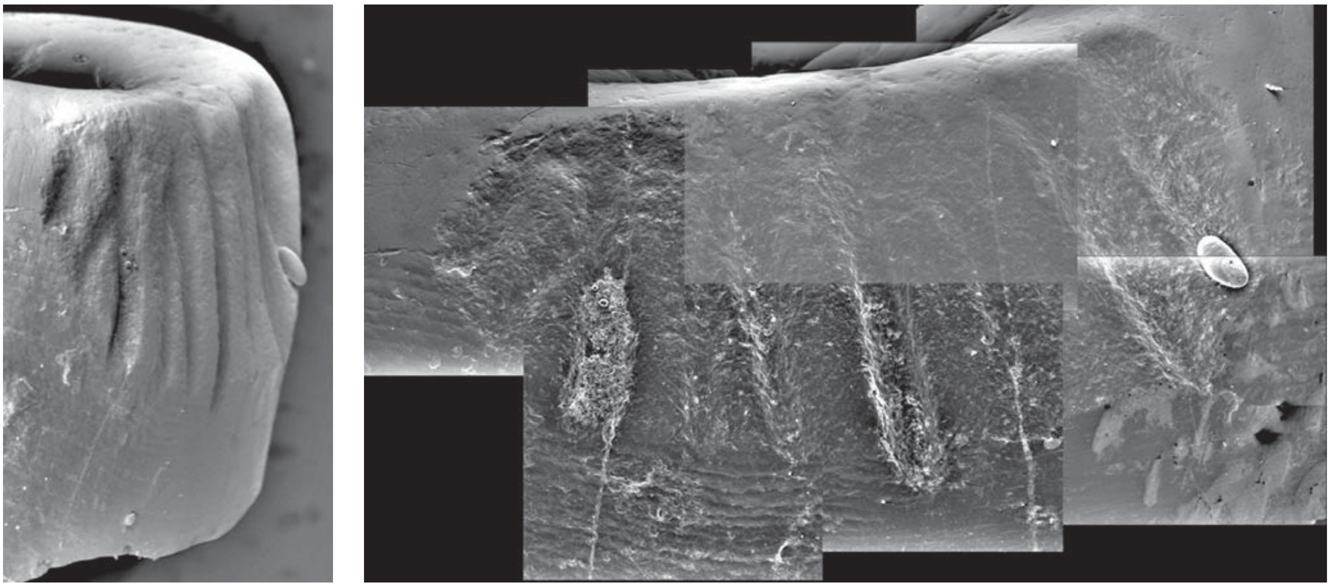

FIGURE 4. Tow views of the inteproximal grooves on the proximal facet of the Figueira Brava tooth.

RESULTS AND DISCUSSION

The subvertical grooves observed on the interproximal wear facets of Cueva de Sidrón and Figueira Brava are well marked, deep grooves, and appear in relatively high numbers within each wear facet. They follow a radial orientation from the occlusal plane of the tooth crown, although not all the grooves converge in the same direction. This subvertical disposition, along with their inter-digitalized morphology, greatly limits the occlusal-to-cervical mobility of teeth during food mastication. The inter-digitalisation of grooves between adjacent teeth also limits tooth movements in the buccal-lingual direction. Such limitation of tooth movements during food processing and chewing could be advantageous for highly abrasive diets (i.e. highly vegetarian diets) since interproximal wear could be significantly reduced as a consequence of tooth mobility annulation. The efficiency of food chewing would also benefit of the lack of tooth-to-tooth movements. As opposed, loose movements between adjacent teeth would eventually result in complete enamel abrasion, greater susceptibility to pathological conditions, such as dental caries and periodontal disease, and less efficiency in tough foods processing. This hypothesis would explain the higher frequency of subvertical grooves in human populations living in arid environments and with highly abrasive diets. The generalized attribution of a mainly carnivorous diet to Neanderthals need not be in contradiction with the necessity of high masticatory forces, as seems to indicate the relevant presence of subvertical grooves in Neanderthals. Both chewing forces and paramasticatory activities in relation to diet may explain the presence of such grooves. However, we support a combined effect of both processes since the buccal microwear pattern of the Neanderthals seems to be indicative of consumption of hard plant food materials in the diet of these populations (Pérez-Pérez *et al.* 2003).

From our point of view, differences in dietary habits and related biomechanical forces, favoured by distinct enamel prisms disposition in the interproximal tooth facets, are necessary to explain the formation of the subvertical grooves. The disposition of perykimata, Retzius lines, and Hunter-Schreger bands in the proximal and distal faces of the premolar and molar tooth crowns, combined with strong forces of the temporal and maseter muscles, could inwardly result in the formation of radial subvertical grooves. However, the correlation between the orientation of the microscopic, subsurface structure of enamel and the gross features of teeth is not well understood (Maas, Dumont 1999). Natural selection could have favoured such enamel structure differences in hominin populations with highly

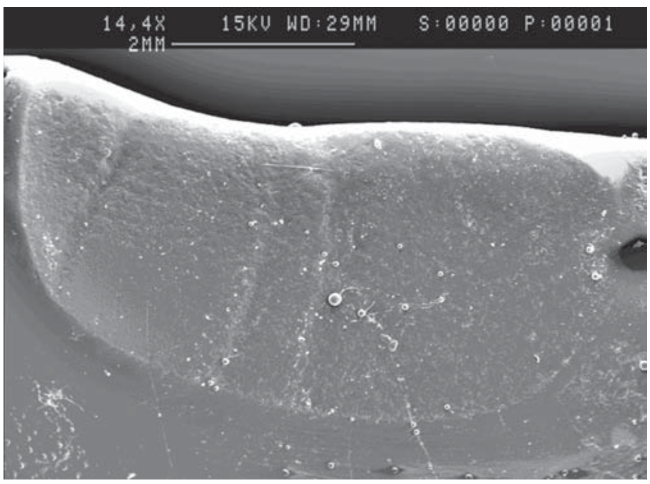

FIGURE 5. Interproximal grooves observed on the interproximal facet of the #237 UB ref. tooth from Sima de los Huesos (Atapuerca).

abrasive and tough diets. Mass and Dumont (1999) already noted that the structure of primate enamel is clearly adaptive, and that the evolution of certain enamel features requires significant alterations of primitive developmental pathways. Enamel research has mostly focused on phylogenetic differences in enamel structure. However, environmental constraints could be determinant in enamel morphology. We already know that among the primates the *Hominidae* show the thickest enamel, and that this could most probably be due to adaptation to abrasive, hard foods ingestion. Further analyses on enamel structure and organization need to take into account ecological and dietary related determinants, and large hominin samples sizes need to be compared.

CONCLUSIONS

Subvertical grooves could be a biological response to selective pressures on primate populations with highly abrasive dietary habits requiring strong biting forces. *Post-mortem* processes and acidic diets can be discarded as factors explaining the presence of subvertical grooves because inter-digitations, non-forming drainage canals, occur between grooves in adjacent, non-isolated teeth, in which wear facets have not been exposed to taphonomic processes. Natural selection might have favoured the formation of subvertical grooves by attenuating tooth movements and reducing inter-proximal wear in populations with highly abrasive diets. Morphological modifications in enamel structure and organization through natural selection should explain the formation of subvertical grooves and the correlation between enamel substructure and macroscopic tooth features should be further investigated.

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