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Teeth and the Past in Portugal: Pathology and the Mesolithic-Neolithic Transition

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Abstract

Carious lesions are considered an important marker of dietary change at the transition from hunting and gathering to horticulture. Within the context of the transition to the Neolithic in Central Portugal, this paper discusses factors which must be taken into consideration in reporting dental pathology frequencies. Three sites are examined, two late Mesolithic shell middens and one early Neolithic burial cave dating before 5500 calBP which is taken to be the end of the transition period. Comparability of results across different burial types and depositional environments requires close attention to methodology. Despite inclusion of necessary detail on caries type, age of onset of pathology and age distribution within the sample, factors such as the use of teeth as tools and post-mortem alteration of teeth may make it impossible to be certain of rates of pathology. Inter-site differences in dental pathology may result, not only from diet, but from differing adult age distributions: when burial modes and deposits are dissimilar, differing diagenesis and taphonomy may further bias pathology rates, as well the use of teeth as tools which can affect attrition, trauma and tooth loss rates.

Cook [1] suggests that a caries rate change is the only reliable marker of the transition to agriculture. The transition period is particularly well represented by skeletal material in Portugal at the Mesolithic shell middens, Moita do Sebastião (Moita) and Cabeço da Arruda (Arruda), dating after 8000 calBP and located on a southern tributary of the Tagus River and at the Early Neolithic cave site of Casa da Moura, north of the Tagus. Arruda dates extend slightly later in time than those for Moita [2] and the transition is defined as prior to 5500 calBP. The transition for these sites is clearly marked by differences in stable isotope values and in burial modes [3].

The primary burials at Moita and Arruda were mixed before and after excavation: the minimum number of individuals (MNI) and their age distribution is best assessed by seriation of the mandibles [4] providing a 'maximum' MNI (Moita, 85; Arruda, 105 [2]). The Casa da Moura skeletons are disarticulated and 74% of the teeth were loose when excavated. Reference to teeth in situ in their alveoli and multiple sorting with varying emphases on crown features, root form and metrical analyses of size and shape has aided identification of these loose teeth. The mandibles with teeth still in the alveoli could be seriated and were analyzed in Portugal in the same way as the Mesolithic mandibles, but analyses of the nearly 5,000 loose teeth were carried out in a laboratory in Canada over several years and included inter- and intra-observer error tests. The MNI for Casa

Table 1. Percentage rate of dental pathology within each of ten (A–J) more or less equal groupings of molar sockets across seriated mandibles

	Moita do Sebastião			Cabeço da Arruda		
	caries	abscessing	pre-mortem tooth loss	caries	abscessing	pre-mortem tooth loss
A	16.0	0.0	0.0	0.0	0.0	0.0
B	0.0	0.0	0.0	0.0	0.0	0.0
C	20.0	0.0	0.0	3.8	0.0	0.0
D	20.8	3.6	3.6	3.7	0.0	0.0
E	10.0	0.0	4.2	18.5	0.0	12.5
F	0.0	0.0	11.5	19.2	0.0	0.0
G	16.0	3.6	3.6	8.3	3.2	16.1
H	19.0	3.6	21.4	12.9	3.0	8.3
I	29.4	24.0	20.0	20.0	8.6	28.2
J	50.0	15.8	78.9	18.8	14.3	41.7
Present/n	31/211	12/256	32/256	25/249	10/309	38/323

da Moura has been estimated as 340 based on M_2 intact teeth and sockets with pre-mortem tooth loss [2]. No doubt some older individuals must be unrepresented in the count.

In considering the value of dental pathology as central evidence for subsistence change, I examine lower molars because good preservation is a characteristic of mandibles and particularly of lower molars. Caries susceptibility depends upon tooth type [5], and tooth type representation in archaeological material is very uneven. Lower molars are best represented [6, 7]: limiting analysis to lower molars ensures comparability between Mesolithic primary and Neolithic ossuary samples.

Periodontal disease will not be discussed here partly because of the presence of matrix or damage. The height of the cemento-enamel junction (CEJ) above the alveolar margin has been recorded for all sites but cannot be discussed in this brief summary.

The Mesolithic mandibles assessed at age ~15 years and over were seriated on attrition. Attrition rate differences, even between the Mesolithic sites, are likely [8]. Moita individuals of ~20 years of age have a higher level of wear for M_1 relative to M_2 and M_3 than Arruda individuals of equivalent age. Sorting by wear stages suggests that Arruda has more older people than Moita: based on hazard rate analyses, significantly more adults survived into higher wear level stages at Arruda than at Moita. This is supported by analyses of Nordin's Index and cortical width and density, all features of the femoral cortex [9].

In table 1 the lower molar sockets for the Mesolithic sites are distributed over ten categories (A–J) with near equal numbers of sockets, in an attempt to understand the relationship of dental pathology to increasing age. This technique of distributing individuals is designed to decrease the effects of unequal wear stage samples and any intra-observer change in wear assessments between the two sites. Moita pathology occurs earlier, despite the possibility of faster wear. This result is equivalent to previous 11 attrition grade distribution results: caries is seen across wear stages at Moita, but is rare in younger individuals at Arruda [9].

At Moita, carious lesions occur before M_3 comes into wear and multiple lesions in one individual are seen as soon as M_3 reaches the first stage of wear. Multiple lesions are not seen at Arruda until category E in an unusual individual with four caries in association with an M_1 having only a trace of mid-occlusal surface enamel left. Tooth loss also occurs earlier at Moita than at Arruda. Abscessing and premortem tooth loss are not seen at Arruda until the second molars have large discrete dentin exposures, whereas they occur when Moita second molars still have no more than point exposures.

Moita caries and tooth loss cannot be ascribed to heavy attrition alone. Moita occlusal lesions occur in the form of small pit and fissure defects in four individuals (in categories A–G) with M_2 enamel barely worn to pinpoint dentin exposure. Open pulp chambers are not seen at Moita (two individuals in category I) until M_2 occlusal enamel survives only as a narrow marginal rim. All carious individuals in the midrange of attrition have multiple lesions on both occlusal and interproximal surfaces.

Stable isotope values differ significantly between the two sites [2, 3], although the distributions overlap. This suggests varying degrees of reliance on estuarine resources and some of the heterogeneity of Mesolithic stable isotope values may reflect changes within the estuarine setting which led eventually to abandonment of the valley [2].

Casa da Moura pathology rates are lower than for the Mesolithic sites [3], but pathology is found in young individuals, even in deciduous dentitions, while no Mesolithic deciduous teeth had lesions. Stable isotopes indicate a homogeneous Early Neolithic diet from terrestrial resources [3].

An initial sample of the in situ Casa da Moura dentitions was observed in 1986, but most were examined in 1989 after detailed study of the loose material. Further examination is ongoing. Overall, in those over the age of ~15 years in the 1989 sample, there was a 9.9% caries rate (27/273) and a 10.5% premortem tooth loss rate (32/305). Equivalent figures for the Mesolithic sites (table 1) are Moita (12.5 and 14.7%) and Arruda (10.0 and 11.8%).

By examining only those mandibles in the 1989 sample with unexpanded points of dentin exposure on M_1, we see that caries occurs early at Casa da Moura. Of the molars in occlusion (103), 12 had caries: two had occlusal pits, two had interproximal lesions just below the facet, two had the interproximal defect enlarged to involve the occlusal surface, two defects at the CEJ in one individual, one carious buccal pit, and one large occlusal cavity. One further individual had two defects, one beginning at the mesial CEJ and the other a huge multi-surface lesion.

Caries type changes across time [3, 6] with occlusal caries rates decreasing between Moita and Arruda ($p = 0.019$) and again between Arruda and Casa da Moura (in situ 1986–89 molars $p = 0.03$, loose $p = 0.015$), while interproximal caries incidences show no significant differences across sites.

The co-occurrence of strong molar attrition and occlusal caries at Moita [10] and the reduction in dental pathology in the late Mesolithic and Early Neolithic perturb the expected pattern [11, 12]. In central Portugal, markedly lower attrition levels (fig. 1a) and a rise in occlusal caries rates do not occur until later in the Neolithic, after 5500 calBP.

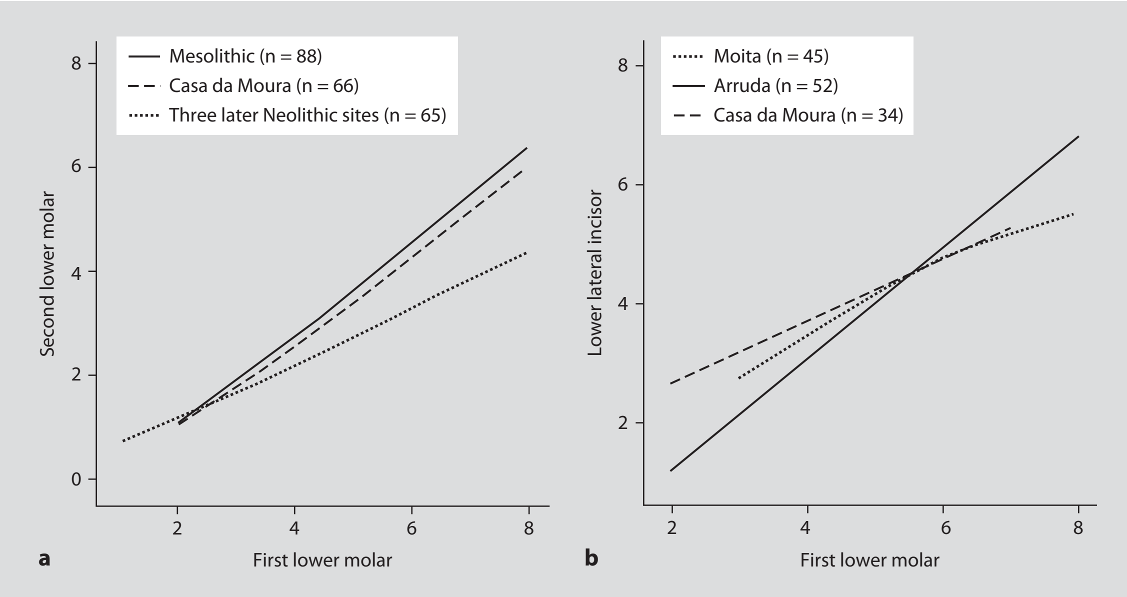

Fig. 1. Loess fit lines using the Epanechnikov kernel to smooth 99% of data points. **a** Comparison of the relative attrition of the permanent first and second lower molars in Portuguese Mesolithic and Neolithic individuals indicates the major change in attrition of lower molars occurred after 5500 calBP. **b** Comparison of the relative attrition of the permanent lower lateral incisors and first lower molars in Portuguese Mesolithic and Neolithic individuals indicates that Casa da Moura had earlier, stronger anterior wear than either of the Mesolithic sites.

Nevertheless, Casa da Moura attrition is reduced. To characterize Early Neolithic loose molar wear adequately, a composite of the approaches of Smith [13] and Lovejoy [14] was developed. Of eight crown heights, the disto-buccal is most closely related to this composite scheme (fig. 2) and this variable is used in comparisons across the 937 Casa da Moura loose lower molars.

A large sample (586) of the loose first and second lower molars was reexamined for caries to record inter-observer differences. The only disagreements among observations occurred with interproximal changes at the CEJ, coded either as grooving or as caries [6]. (Note that the grooves discussed here did not result from the use of toothpicks. Toothpick grooves occur and are easily distinguished from CEJ grooving [6].)

To What Extent Is Grooving Carious or Post-Mortem?

Grooving at the CEJ was studied in detail in Casa da Moura loose canines, in which it occurs without relation to hypercementosis, rotation, crown dimensions, attrition, or jaw. A further consideration is the use of anterior teeth in leatherworking: identified as a factor in Mesolithic anterior dental attrition [15], the Early Neolithic anterior wear is more extreme. Examination at up to ×1,000 shows that consistently oriented criss-crossing striations resulted from this apparent use of the anterior teeth. Such lingual polishing occurs mostly in the maxilla and most strongly on the left (left upper canines show lingual polish significantly more often than the right). Casa da Moura mandibular anterior attrition

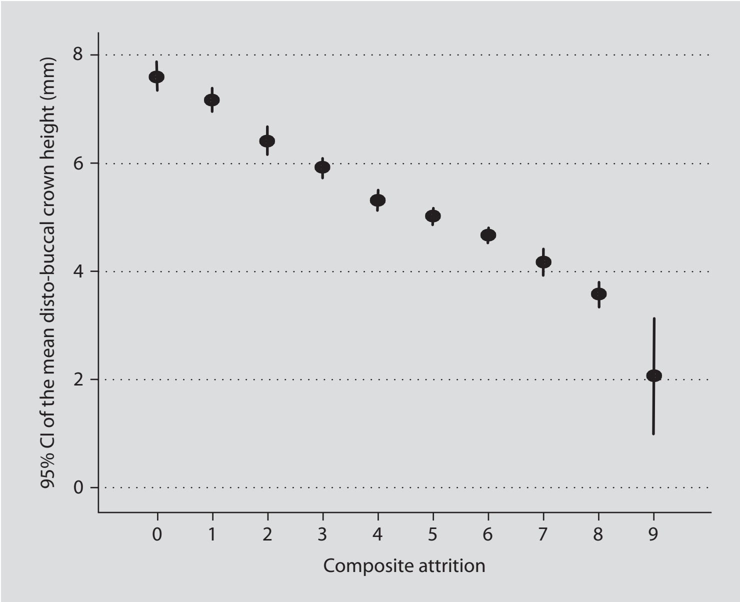

Fig. 2. Casa da Moura composite attrition and the disto-buccal crown height (323 lower molars): loess line at 99% (Epanechnikov) is virtually identical with a lineal regression line, r = 0.840.

is established earlier and more strongly than at Moita and Arruda (fig. 1b): lateral incisors are graphed because the central lower incisors are lost pre-mortem significantly more frequently than the laterals. It is clear that Casa da Moura teeth are affected by their use as tools. Grooving on the anterior tooth crowns, as distinct from the CEJ, is also attributable to leatherworking. There is no relationship between CEJ grooving and canine lingual polish.

Trauma of the canines is also common. Trauma in the lower canines occurs significantly more often on the left (of which 26% are chipped) than on the right ($p = 0.004$), and major breakage occurs only on the left. However, CEJ grooving is not related to the presence, type or location of trauma. CEJ grooves are unlikely to be the result of the type of trauma that gives rise to abfraction [16].

Much CEJ grooving seems to be post-mortem [6]. Grooving is unlikely to significantly alter caries incidence in canines, but it will certainly affect the loose Casa da Moura lower molar caries rate. Of the interproximal lesions for which the origin could be pinpointed, 11 were at the CEJ, and only three were subfacet. CEJ grooving cannot always be distinguished from caries with complete certainty. The grooving might also be initiated by carious lesions and post-mortem grooving could mask the presence of such lesions. In sites in which this type of diagenesis is common, the caries rate is uncertain.

CEJ grooving cannot be clearly identified as specific to individuals at higher wear levels (reduced disto-buccal crown heights). In a sample of 221 lower molars in which attrition was at least at the level of two or three pinpoint exposures of dentin, 17 had CEJ grooving. Neither crown height means nor variances were significantly different between those with and without grooving: the difference in means between carious molars (28) and those without caries (192) was significant ($p = 0.04$) and trauma is also significantly associated with lowered disto-buccal crown height ($p = 0.000$). There is no association between CEJ grooving and enamel chipping ($p = 0.5$). Caries and trauma are age-dependent, but CEJ grooving cannot be shown to be age-dependent.

Discussion

There are changes in dental pathology within the late Mesolithic, but no simple increase in the Early Neolithic, despite differences in the stable isotopes. Analysis by wear levels and by metric variables systematically altered by attrition is required to fully describe the changes. Simple reporting of caries rates, without attention to the age bias in the sample, without examining the age distribution of pathology, without recording type and location of lesions and without consideration of diagenesis and tooth type, is not likely to give us a fully accurate picture of the past.

References

1 Cook DC: Maize and Mississippians in the American midwest 20 years later; in Cohen, MN, Crane-Kramer GMM, Larsen CS (eds): Ancient Health: Skeletal Indicators of Agricultural and Economic Intensification. Bioarchaeological Interpretations of the Human Past: Local Regional and Global Perspectives. Gainesville, University Press of Florida, 2007, pp 10–19.

2 Jackes M, Meiklejohn C: The Paleodemography of Central Portugal and the Mesolithic-Neolithic transition; in Bocquet-Appel JP (ed): Recent Advances in Paleodemography: Data, Techniques, Patterns. Dordrecht, Springer, 2008, pp 209–258.

3 Lubell D, Jackes M, Schwarcz H, Knyf M, Meiklejohn C: The Mesolithic-Neolithic transition in Portugal: isotopic and dental evidence of diet. J Archaeol Sci 1994;21:201–216.

4 Jackes M, Meiklejohn C: Building a method for the study of the Mesolithic-Neolithic transition in Portugal; in Budja M (ed): Neolithic Studies 11. Documenta Praehistorica 2004, vol 31, pp 89–111.

5 Batchelor PA, Sheiham A: Grouping of tooth surfaces by susceptibility to caries: a study in 5–16 year-old children. BMC Oral Health 2004;4:2. http://www.biomedcentral.com/1472–6831/4/2

6 Jackes M, Lubell D: Dental pathology and diet: second thoughts; in Otte M (ed): Nature et Culture: Actes du Colloque International de Liège, 13–17 Décembre 1993. Liège, Études et Recherches Archéologiques de L'Université de Liège, 1996, no 68, pp 457–480.

7 Jackes M: ~~From individuals to populations: representativeness of the sample;~~ in Agarwal S, Glencross B (eds): A Handbook of Social Bioarchaeology. Blackwell Studies in Global Archaeology. Oxford, Wiley-Blackwell, in press.

8 Jackes M, Lubell D: Human skeletal biology and the Mesolithic-Neolithic transition in Portugal; in A. Thévenin (ed.), dir. scientifique P. Bintz: Europe des derniers chasseurs Épipaléolithique et Mésolithique: actes du 5e colloque international UISPP, commission XII, Grenoble, 18–23 septembre 1995. Paris, Éditions du CTHS, 1999, pp 59–64.

9 Lubell D, Jackes M: Portuguese Mesolithic-Neolithic subsistence and settlement. Riv Antropol 1988;LXVI(suppl):231–248.

10 Meiklejohn C, Wyman JM, Schentag CT: Caries and attrition: dependent or independent variables? Int J Anthropol 1992;7:17–22.

11 Meiklejohn C, Zvelebil M: 1991 Health status of European populations at the agricultural transition and implications for the causes and mechanisms of the adoption of farming; in Bush H, Zvelebil M (eds): Health in Past Societies. Br Archaeol Rep Int Ser 567:129–146.

12 Jackes M, Lubell D, Meiklejohn C: Healthy but mortal: human biology and the first farmers of Western Europe. Antiquity 1997;71:639–658.

13 Smith BH: Patterns of molar wear in hunter-gatherers and agriculturalists Am J Phys Anthropol 1984;63:39–56.

14 Lovejoy CO: Dental wear in the Libben population: its functional pattern and role in the determination of adult skeletal age at death. Am J Phys Anthropol 1985;68:47–56.

15 Lefèvre J: Étude odontologique des hommes de Muge. Bull Mem Soc Anthropol Paris 1973;10:301–333.

16 Palamara JEA, Palamara D, Messer HH, Tyas MJ: Tooth morphology and characteristics of non-carious cervical lesions. J Dent 2006;34:185–194.

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